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VOL. CXXXVII.—No. 3572] LONDON: FRIDAY EVENING, JUNE 13, 1924 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere road, Lambeth, S.E. 1, REQUIRES:—

1. COPPER FIRE-BOX PLATES.
2. GIRDER BRIDGES.
3. GALVANISED STEEL SHEETS, CORRUGATED and PLAIN.

Tenders due on the 1st July, 1924, for No. 1 and on the 4th July, 1924, for Nos. 2 and 3.
Tender forms obtainable from above. 6035

H.M. Oil Fuel Depôt, KILLINGHOLME, LINCS.

SALE OF SURPLUS STORES.

The Admiralty offer FOR SALE by TENDER the following new and second-hand SURPLUS MATERIALS:—

Heavy Cast Iron Pipes, Bends, Collars, and Specials, 4in. to 18in. diameter; Sluice Valves and Gun-metal Screwed Outlets, 8in. diameter; Expansion Joints for 8in. to 12in. mains; Jointing Rings for Flanged Pipes, 3in. to 18in. diameter; Bull-head and F.B. Rails, 54-96 lb. per yard; Light Rails, F.B. Section, 14 lb. per yard; Cast Iron Single and Check Chairs, Sleepers, Fish-plates, and Miscellaneous Railway Materials; 2000 Feet Miscellaneous Wrot. Deal Moulding; 1½in. Wrot. Iron Tube and Fittings; Miscellaneous Ironmongery and Plumbers' Brasswork; Stocks and Dies in sets; "Flottmann" Steam Drill and Fittings; Iron Pulley Blocks; Fire-bricks and Lumps; Drain Pipes and Sundries.

The stores can be viewed at the depot on application at the Works Dept. Office.

A detailed list of the stores and form of Tender can be obtained at the Depot, and also from the Officer-in-Charge of Works, H.M. Training Establishment, Shotley, near Ipswich.

Tenders will be returnable to the OFFICER-IN-CHARGE of WORKS, H.M. Training Establishment, Shotley, near Ipswich, by Noon on Friday, 27th June. 5937

Assistant Engineer REQUIRED by the GOVERNMENT of SIERRA LEONE, for the RAILWAY DEPARTMENT, for two tours of from 12 to 18 months' service. Salary £480 for the first three years of service, then £510, rising to £720 a year by annual increments of £30, and thence to £920 a year by annual increments of £40. Free quarters and first-class passages. Liberal leave at home on full salary. Candidates, 28 to 35 years of age, must have had good experience as civil engineers on railway maintenance.—Apply at once, in writing, giving brief outline of qualifications and experience and stating age, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting clearly at head of application M/12,756. 6000

Section Engineers (4) REQUIRED for the Construction Branch of the FEDERATED MALAY STATES RAILWAYS, for four years' service, with possible extension. Salary 400 dollars a month, rising to 475 dollars a month by annual increments of 25 dollars a month, plus a temporary non-pensionable allowance of 10 per cent., which is liable to cancellation or revision, plus a commuted field allowance of 50 dollars a month. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but the purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passages provided. On expiration of agreement a bonus of six months' salary may be allowed provided the work and conduct of the person engaged have been in every way satisfactory. Candidates, age preferably between 30 to 38 and unmarried, must be fully qualified Railway Engineers who have received good training and experience on recognised European, American, or Colonial Railways. Members or Associate Members of the Institution of Civil Engineers preferred.

Apply at once by letter, stating age, whether married or single, and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting at top of application M/12,797. 6001

Bombay, Baroda, and Central INDIA RAILWAY.

The Directors are prepared to receive up to Noon on Friday, 27th June, TENDERS for the SUPPLY of:—

1. STEEL MATERIAL (Channels, Angles, Plates, &c.).
2. BOLTS, NUTS and RIVETS.
3. CHEMICALLY DRESSED WAGON COVERS, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for Nos. 1 and 2 and 10s. each for No. 3 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices: 91, Petty France, Westminster, S.W. 1, 6th June, 1924. 6017

County of London. REPAIRS TO THE PAVEMENTS OF BLACKWALL AND ROTHERHITHE TUNNELS.

The London County Council invites TENDERS for REPAIRS to the PAVEMENTS of BLACKWALL and ROTHERHITHE TUNNELS.

The specification, form of Tender, &c., may be obtained on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 30th June, 1924, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD, Clerk of the London County Council. 6013

PUBLIC NOTICES

Ilfracombe Urban District COUNCIL.

TENDERS are INVITED for the SUPPLY and DELIVERY of a 16in. STONE BREAKER fitted with ROTARY SCREEN.

Full particulars may be obtained from the undersigned.

Tenders, endorsed and addressed to H. G. Brede, Esq., Town Clerk, Town Hall, Ilfracombe, will be received not later than Noon on Monday, June 23rd, 1924.

FRED. B. GOODMAN, Engineer and Surveyor. 6023

Ilfracombe Urban District COUNCIL.

TENDERS are INVITED for the SUPPLY and DELIVERY of a TEN-TON STEAM ROLLER. Further particulars may be obtained from the undersigned.

Tenders, endorsed and addressed to H. G. Brede, Esq., Town Clerk, Town Hall, Ilfracombe, will be received not later than Noon on Monday, June 23rd, 1924.

FRED B. GOODMAN, Engineer and Surveyor. 6024

Keighley Corporation. SLADEN VALLEY WATERWORKS. BRACKEN BANK RESERVOIR.

CONTRACT A A.—ROLLED STEEL JOISTS, &c.

The Corporation of Keighley invite TENDERS for the MANUFACTURE and DELIVERY of ROLLED STEEL JOISTS and other STEEL WORK required in connection with the construction on the Bracken Bank Reservoir Works.

The drawings may be seen and copies of the specification, form of Tender, and schedule of prices may be obtained from the Engineer, Mr. M. Ratcliffe Barnett, M. Inst. C.E., Town Hall, Keighley, on and after Saturday, 14th June, 1924.

Sealed Tenders, endorsed "Keighley Waterworks, Bracken Bank Reservoir, Contract A A," addressed to the Chairman of the Waterworks Committee, must be delivered to the undersigned on or before the 14th July, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender.

SMITH TERRY, Town Clerk.

Town Hall, Keighley, June 4th, 1924. 6006

Keighley Corporation. SLADEN VALLEY WATERWORKS. LOWER LAITHE RESERVOIR.

The Corporation of Keighley are prepared to receive DESIGNS and TENDERS for the CONSTRUCTION and ERECTION on the site of the above Reservoir of a STEEL FOOTBRIDGE, 6ft. wide, and consisting of two spans of 80ft. each, for access to the valve tower.

A type drawing and other particulars may be obtained from Mr. M. Ratcliffe Barnett, M. Inst. C.E., the Waterworks Engineer, Town Hall, Keighley.

Sealed Tenders must be delivered on or before the 14th July, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender.

SMITH TERRY, Town Clerk.

Town Hall, Keighley, June, 1924. 6007

"THE ENGINEER" WANTED.

WANTED, VOLUMES of "THE ENGINEER" from July, 1914, to December, 1921; must be clean and complete.—Write, stating lowest price, P1000, The Engineer Office. P1000

PUBLIC NOTICES

East Indian Railway.

The Directors are prepared to receive up to 11 a.m. on Wednesday, the 25th June, TENDERS for the SUPPLY of:—

SPRING STEEL.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE, Secretary.

73-76, King William-street, London, E.C. 4, 12th June, 1924. 6043

Metropolitan Water Board. MAIN, CRICKLEWOOD TO MARBLE ARCH. TENDERS FOR THE LAYING AND JOINTING OF 42in. AND 36in. DIAMETER CAST IRON MAINS BETWEEN CRICKLEWOOD AND MARBLE ARCH.

The Metropolitan Water Board invite TENDERS for the LAYING of 42in. and 36in. internal diameter WATER MAINS from the Board's Works at Cricklewood, in the Parish of Willesden, to Seymour-street, in the Parish of St. Marylebone, together with contingent Works.

Drawings, conditions of contract and specification may be inspected without payment of fee at the offices of the Board, Chief Engineer's Department (Room 201), on and after 16th June, 1924.

Form of Tender, conditions of contract and specification, bills of quantities, and schedules of prices, together with drawings and a spare copy of the bills of quantities and schedules of prices, may be obtained on and after 19th June, 1924, from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of £30, which sum must be deposited with the Accountant to the Board, and will be returned on receipt of a bona fide Tender, accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities and schedules of prices, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, Clerkenwell, E.C. 1," and endorsed "Tender for Main Laying, Cricklewood to Marble Arch," must be delivered at the offices of the Board (Room 123) not later than 10 a.m. on Monday, 7th July, 1924.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER, Clerk of the Board.

Offices of the Board, New River Head, Clerkenwell, E.C. 1, 10th June, 1924. 6028

The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.

The Directors are prepared to receive TENDERS for:—

METRE GAUGE:

24 BOGIE OPEN HIGH-SIDED WAGONS, 35ft. long (I.R.C.A. Standard Type, M.B.C.2);
6 BOGIE RAIL WAGONS, 43ft. long (I.R.C.A. Standard Type, M.B.D.1);

in accordance with the specification, which may be seen at the offices of the Company. The charge for the specification is One Guinea, which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 1st July, 1924, and marked "Tender for Wagons."

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices: 25, Buckingham Palace-road, Westminster, S.W. 1, 6th June, 1924. 6005

PUBLIC NOTICES

State Electricity Commission OF VICTORIA. MELBOURNE, VICTORIA, AUSTRALIA.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification will be available upon application to the Agent-General for Victoria, Melbourne-place, Strand, London, W.C. 2.

SPECIFICATION NO. 24/38.—BUSHING INSULATORS FOR 6600 V. TRIFURCATING BOXES.

CHARGE.—£2 2s. for the first three copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each. This charge is not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £10 10s. is to be lodged with Tender.

The specifications may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 15th September, 1924.

R. LIDDELOW, Secretary. 5936

The Scottish Gympie Gold MINES, LIMITED. (IN LIQUIDATION.)

The subscribers have received intimation by cable that the PLANT and MACHINERY at the Mine situated at Gympie, Queensland, will be exposed for SALE by AUCTION on JULY 7th to 11th inclusive. Catalogues of the sale are now available, and parties interested are requested to communicate by cable with their representatives in the Dominion, who will receive copies of the catalogue and all other particulars on application to the Liquidators' Attorney, Colonel D. E. Reid, D.S.O., Gympie, Queensland, or Messrs. Cameron, Sutherland and Seaward, Ltd., Machinery Merchants, Sydney, who have been entrusted with the sale.

C. D. R. WALKER, C.A., W. G. DUNLOP, C.A., Joint Liquidators.

168, St. Vincent-street, Glasgow, 6th June, 1924. 6010

Hull Corporation. FOREMAN MECHANIC.

The Corporation are prepared to receive APPLICATIONS for the POST of FOREMAN MECHANIC in the City Engineer's Department, at a commencing salary of £300 per annum (no bonus).

Candidates must have good experience in the charge of workshops and an intimate knowledge of Transport Vehicles and Smithing Work.

Applications to state the nature of military service, if any.

The post is a designated post under the Superannuation Act, and the salary is subject to the deduction of the usual contributions.

Applications, endorsed "Foreman Mechanic," are to be addressed to the City Engineer and delivered on or before Tuesday, 17th June.

By Order, F. W. BRICKNELL, City Engineer.

Guildhall, Hull, 6th June, 1924. 6015

The County of London Electric SUPPLY COMPANY, LIMITED. BARKING POWER STATION.

The County of London Electric Supply Company, Ltd., REQUIRE the SERVICES of THREE ENGINEERS for the Operation of their Power Station at Barking, containing 100,000 K.Ws. Plant, which is now nearing completion. The positions for which APPLICATIONS are INVITED are:—

1. RESIDENT ENGINEER.
2. BOILER-HOUSE SUPERINTENDENT.
3. TURBINE-HOUSE SUPERINTENDENT.

Applicants must have experience of the operation of a large modern Power Station.

Applications, with copies of testimonials (not originals), should be sent before the 21st June to the MANAGER and SECRETARY, County of London Electric Supply Co., Ltd., Moorgate-court, Moorgate-place, E.C. 2, and should be accompanied by a short statement of the experience of the applicant, his age and whether he is married or single.

The salary attaching to each position will depend upon the qualifications of the successful applicant. 6012

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SITUATIONS OPEN

WANTED, an ELECTRICAL ENGINEER, with several years' experience in Design and Layout of Electrical Wiring, Switching, and Instrument Equipment as applied to electric power stations. Replies should give full particulars of education and experience, with names of companies served and periods of service. Salary expected should be stated and photo enclosed if available.—Address, 5998, The Engineer Office. 5998 A

WANTED, REPRESENTATIVES for Old-established Engineering Firm specialising in Waterworks Fittings. Public school education and previous experience will be an advantage.—Address, stating age, qualifications, salary required, and, if possible, enclosing photograph, 6033, The Engineer Office. 6033 A

ASSISTANT CHIEF AERO-ENGINE TESTER REQUIRED; must be thoroughly experienced in Testing High-powered Aero-engines to Government standards and hold ground engineer's certificate.—Address, stating age, experience, and salary required, 6018, The Engineer Office. 6018 A

COMPETENT TEST ENGINEER WANTED in Large Engineering Works. Must have had sound technical and thorough practical training, with experience of various types of Internal Combustion Engines, including Diesels, and High-power Aero-engines. Initiative and ability to diagnose troubles essential.—Address, stating age, experience, and salary required, 6039, The Engineer Office. 6039 A

ENGINEER REQUIRED by Yorkshire Municipal Electricity Supply Undertaking, to Take Charge of the Operation (but not the maintenance) of Boiler Plant comprising over 20 Babcock and Wilcox water-tube boilers. Applicants should have had experience in the control of men, possess a sound knowledge of the principles of combustion and efficient operation of steam-raising plant, and be capable of organising, carrying out and summarising the results of efficiency tests. Salary and conditions in accordance with the National Joint Board Schedule (salary at present £376 per annum).—Applications, in candidates' own handwriting, giving full particulars of experience and training, particularly with reference to the points mentioned above, to be made to P9199, The Engineer Office, and to be received not later than June 27th. P9199 A

ENGINEER REQUIRED for Japan. Must have expert knowledge of Machine Tools, good education and address.—Apply by letter, stating age, experience and salary required, to THE CHAIRMAN, ASSOCIATED BRITISH MACHINE TOOL MAKERS, Ltd., 17, Grosvenor-gardens, London, S.W. 1. 5934 A

STEEL CASTINGS.—REPRESENTATIVE REQUIRED for Steel Foundry; capacity 300 tons per month, with available space for extension. Applicant must have influence and connection. Seat on Board may be arranged. State fullest particulars, salary required, in confidence.—Address, 5983, The Engineer Office. 5983 A

WORKS MANAGER (Really High-class) REQUIRED for modern Engineering Works in West Riding, Yorkshire; must have organising abilities, able to control workmen and foremen, and have held similar successful position. State fullest particulars.—Address, 5947, The Engineer Office. 5947 A

PHOTO BLUE PRINTING.—MAN WANTED, to Take Charge of Manufacturing Engineers' Blue Printing Room and Drawing Files. Knowledge of Hall's Rotary Photo-Copiers and modern Blue Printing, Photostatic, and Reproduction Processes essential, together with experience of routine filing and card indexing.—Address, stating age, experience, and salary required, 5855, The Engineer Office. 5855 A

SUPERINTENDENT.—REQUIRED by a Large and important Motor Manufacturing Firm, a General MACHINE SHOP SUPERINTENDENT. Must be thoroughly familiar with latest shop practice. Only men who have held similar positions on high-grade work need apply, stating age, previous positions in chronological order, and salary required.—Address, 6040, The Engineer Office. 6040 A

WANTED, Capable DRAUGHTSMAN, with Experience in Structural Ironwork and Concrete Construction.—Address with full details, 5907, The Engineer Office. 5907 A

CONSTRUCTIONAL DRAUGHTSMAN. Energetic man with sound theoretical knowledge and practical experience in all descriptions of Steel Constructional Works.—Apply, stating age, qualification, and salary required, to Constructional Dept., PRODINGHAM IRON and STEEL CO., Ltd., Scunthorpe, Lincs. 5995 A

DAVID BROWN and SONS, Ltd., REQUIRE the SERVICES of a First-class MACHINE TOOL DRAUGHTSMAN. A wide knowledge of the theory of Gearing essential.—Apply, giving full particulars, Park Works, Lockwood, Huddersfield. 5996 A

DRAUGHTSMAN REQUIRED for Dredger Work, London district; good general knowledge of Heavy Machinery and Structural Steel Work essential. Must have good experience and references. Salary £6 per week.—Address, 6042, The Engineer Office. 6042 A

DRAUGHTSMAN WANTED by Firm in the Midlands; thoroughly experienced in Electric Lift Work.—Address, stating age, experience, and salary required, 6030, The Engineer Office. 6030 A

HEATING and VENTILATING DRAUGHTSMAN REQUIRED by old-established firm in London. Experience in preparing schemes and taking off quantities essential.—Address, stating age, experience, and salary, 6002, The Engineer Office. 6002 A

PUMPING MACHINERY. — DRAUGHTSMAN WANTED, capable of designing and calculating. State experience, age, and salary required.—Address, 6022, The Engineer Office. 6022 A

REFRIGERATION.—Good DRAUGHTSMAN REQUIRED. Works, London area. Experience in Refrigeration essential. Ability to design compressors a recommendation.—Write, stating age, experience, and salary required, Box 1433, Sells Advertising Offices, Fleet-street, E.C. 4. 5999 A

REINFORCED CONCRETE DESIGNER.—A Competent DESIGNER is REQUIRED with previous specialist experience in the design of all types of Reinforced Concrete Structures.—Reply, stating age, experience, and salary required, to Box 681, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 6016 A

STRUCTURAL STEEL WORK DRAUGHTSMAN REQUIRED; experience in rapid and accurate preparation of details of Steel-framed Buildings, especially to L.C.C. requirements. State age, full particulars of qualifications and experience, and salary required.—Address, 6025, The Engineer Office. 6025 A

WORKING DRAUGHTSMAN REQUIRED IMMEDIATELY: Air Compressor experience essential.—Address, 6036, The Engineer Office. 6036 A

PETTERS LIMITED, Oil Engine Manufacturers' Yeovil, have a VACANCY for a thoroughly competent and energetic FOUNDRY FOREMAN to Take Full Charge of Foundry under the Managing Director. He must have had first-class experience in the repetition production of Engine Castings and knowledge of the operation of hydraulic and jarring moulding machines, and preferably have already held a similar position elsewhere. Applicants, who should be between 30 and 45 years of age, should give full particulars of their experience and state salary required. —All applications to be addressed to the SECRETARY, Petters Limited, Yeovil. 5993 A

FOUNDRY FOREMAN WANTED in Works Near London, producing machine and general castings in iron, brass, bronze, and aluminium. Good experience is necessary in all branches of foundry practice, including machine moulding. Applicant must be strict disciplinarian, good organiser, and capable of producing high-class work at competitive prices. State salary reqd., age, details of experience, and when at liberty.—Address, 6041, The Engineer Office. 6041 A

SITUATIONS WANTED

A.M.I.C.E. (23), Works and D.O. Training, Experience of manufacture and maintenance locomotives, stationary engines and boilers, internal combustion, hydraulic and general engineering, used to control of large staffs, DESIRES POST, works or office.—Address, P9200, The Engineer Office. P9200 B

ENGINEER (33), A.M.I. Mar. E., B.O.T. 1st Class Certificate, experienced in the supervision and upkeep of engines, boilers, &c. (has been i/c of 20,000 H.P.), hydraulic and generating installations, expert knowledge of refrigerating machinery, CO_2, NH_3 and compressed air, SEEKS POSITION of RESPONSIBILITY, home or abroad.—Address, P9197, The Engineer Office. P9197 B

ENGINEER (23) DESIRES POST to Gain Experience. Small salary.—Address, P9202, The Engineer Office. P9202 B

ENGINEER REPRESENTATIVE.—ENGINEER DESIRES APPOINTMENT as Resident Agent in London for provincial concern. All-round experience, commercial, technical, practical, draughtsman. —Address, P9196, The Engineer Office. P9196 B

ENGINEER (36) SEEKS SITUATION; 20 Years' good all-round experience, shops, steam engines, pumps, factory maintenance; any district.—J. T., 1, Rostrevor-road, S.W. 6. P9203 B

ENGINEER (30), Shops, D.O. and Marine Experience, pumps, distillers, elec. light, installation, maintenance, B.O.T. certificate, petrol engines, hard worker, excellent refs., DESIRES POST.—Address, P9162, The Engineer Office. P9162 B

ENGINEER, Wide Experience, Both Technical and commercial, with large well-known progressive companies, shortly at liberty, DESIRES responsible APPOINTMENT. Highest qualifications and references.—Address, P9190, The Engineer Office. P9190 B

ENGINEER, with Long and Varied Practical Experience, construction, works management, and commercial, SEEKS APPOINTMENT with modest remuneration.—Address, P9189, The Engineer Office. P9189 B

ENGINEER, Works Manager, Machine Tools, Petrol engines and general engineering, good organiser, modern production methods, highest references, DESIRES CHANGE.—Address, P9208, The Engineer Office. P9208 B

ENGINEER (32), Working, Diploma of R.J.C., Glasgow, fitter and turner, wide experience in I.C. engines, including motor car engines, SEEKS EMPLOYMENT at home or abroad.—Address, P9209, The Engineer Office. P9209 B

EXP. CIVIL ENGINEER, Just Finished Contract, REQUIRES fresh ENGAGEMENT in or near London; first-class references.—Address, P9192, The Engineer Office. P9192 B

YOUNG CIVIL ENGINEER (24), 3 Yrs. Tech. train., 4 yrs. pub. works exp., first-class draughtsman, REQUIRES progressive POSITION near London.—Address, P9193, The Engineer Office. P9193 B

MECH. ENGINEERING.—Energetic YOUNG MAN, good education, DESIRES CHANGE to any progressive position, home or abroad; pref. Assistant Engineer; not afraid of work, at present draughtsman; 4½ yrs. shops, 3 yrs. D.O., gen. engineers, tech. school, levelling; reasonable salary.—Address, P9194, The Engineer Office. P9194 B

MECHANICAL DRAUGHTSMAN SEEKS SITUATION; 3 years' shop experience, 5 years drawing-office, general work.—V. O'KANE, 1, Florence-terrace, Londonderry. 6003 B

SALES ENGINEER, with 20 Years' Technical, Commercial, and selling experience in coal, iron, steel and allied trades, DESIRES POSITION as REPRESENTATIVE or SALES MANAGER with first-class firm. Excellent business connections and references; tactful, energetic. Fullest particulars given.—Address, P9207, The Engineer Office. P9207 B

DRAUGHTSMAN (Senior) SEEKS ENGAGEMENT, London district; all phases of general engineering; a capable machine designer, reliable, quick, inventive. —Address, P9204, The Engineer Office. P9204 B

FOREMAN SMITH DESIRES SITUATION in Railway Carriage and Wagon Works; used to designing tools in general, estimating, ordering all material, &c.—Address, P9198, The Engineer Office. P9198 B

POSITION WANTED, Foundry Foreman, Manager (48), expert, practical knowledge and abilities in foundry work and management of men; references for capabilities, character, &c.—Address, P9201, The Engineer Office. P9201 B

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OPPORTUNITY is Available for ENGINEER to JOIN PRIVATE LIMITED COMPANY in Yorkshire. Works comprise pattern shop, mechanics' shop and foundry. Small investment for directorship. It is essential that applicants have medium weight speciality to develop.—Address, P9205, The Engineer Office. P9205 C

PARTNERSHIP.—Owing to the Death of a Director, a PRIVATE LIMITED COMPANY, manufacturing small tools, with a world-wide trade, are OPEN to APPOINT an energetic MAN willing to take over 2000 shares now available, with suitable previous experience, to act as SALES MANAGER and ASSISTANT to MANAGING DIRECTOR, at a salary of £200 to £450 per annum. Replies (which will be treated in strictest confidence) must give full details as to previous experience and state when can take up duties.—Address, 6038, The Engineer Office. 6038 C

WELL-ESTABLISHED ENGINEERING CONCERN OPEN to RECEIVE well-educated YOUTH. Principals are without successors. Capital necessary, but not of immediate concern.—Address, P9206, The Engineer Office. P9206 C

AGENCIES

RAILWAY AND DOCK ENGINEERS

ARE REQUESTED to SEND INQUIRIES for all RAILWAY MATERIALS and ROLLING STOCK, any quantity, for all gauges, to—

"EXPORT DEPT."

R. H. NEAL and CO.

Plant House,

EALING, LONDON, W. 5. 5368 D

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

The Astronomer Royal's Report.

THE report for the year, presented by the Astronomer Royal to the Board of Visitors on the occasion of the annual inspection last Saturday, was as usual distinguished by that aloofness from mundane affairs which characterises astronomy and astronomers. It is true that with meticulous care a record was given of the number of charwomen and other important personages employed at the observatory, of the number of books missing from the library, and of the painting and repairing work carried out. In the main, however, Sir Frank Dyson was concerned with such matters as sun spots—a new cycle is on the advance—the proper motions of the stars—one star has been discovered with a movement of more than 50 seconds of arc in a hundred years—and the errors in the tables of the moon's motion. Contact with the outside world was, however, established in one important field. Since 1840 continuous magnetic observations have been made at Greenwich, but the approaching electrification of the lines of the Southern Railway in the neighbourhood of the Observatory has made it regrettably necessary to transfer the work elsewhere. A suitable site, free from interference, has been found in Lat. 51° 11′ 3″ N, Long. 0° 23′ 12″ W, or, to speak in common or postal parlance, at Abinger Bottom, Leith Hill, Surrey. Here, on a 10-acre plot 800ft. above sea level, work has now been begun on the new station, and during the summer it is expected that houses for the magnetographs, a resident observer and a caretaker will be completed.

French Colonial Exhibition.

WHILE the proposal to hold an Inter-Allied Colonial Exhibition in Paris in 1926 appears to be compromised by the difficulty of carrying it out in the allotted time, the Colonial Institute of Marseilles has decided to organise a permanent exhibition on the site of the remarkably successful exhibition held in that town two years ago. The intention is to devote a building to each group of products, in which each colony producing them will be represented. The buyer will thus be able to compare similar products from the different colonies, and there will be officers to provide full information and transact business on behalf of the exhibitors. It is hoped by this means to divert to the colonies a good deal of the business in raw material which is going to foreign countries.

Extensions at the Loughborough Electricity Works.

ON Thursday of last week an extension to the Loughborough electricity works was officially opened. The original plant installed in this station, which was opened in 1904, consisted of two 250-kilowatt Brush-Parsons direct-current turbo sets, each rated at 250 kilowatts, these being the first turbo generators which the Brush Company built. In 1917 the maximum load on the station reached 400 kilowatts, and the original generators were then replaced by more modern and larger Brush machines, each capable of developing 350 kilowatts. In 1914 it was decided to change over to the alternating-current system, and a 1000-kilowatt three-phase Brush-Ljungström turbo set was installed, together with a 500-kilowatt Siemens rotary converter. Two Babcock boilers, with an evaporative capacity of 22,000 lb. of water per hour were also provided in place of the original Danks boilers. The recent extensions include a 3000-kilowatt Brush-Ljungström turbo alternator, with condensing plant, a 1000-kilowatt British Thomson-Houston rotary converter, a Vickers-Spearing boiler and direct-current and extra high-tension switchgear supplied by Bertram Thomas and A. Reyrolle and Co., Limited, respectively. New building work has also been carried out, and new extra high-tension and low-tension feeder and distribution cables have been put into use.

Waterloo Bridge.

NO clear statement regarding the cause of the subsidence which has led to the closing of Waterloo Bridge has yet been made, but some details mentioned in Parliament last week by Sir Cyril Cobb provide a certain amount of technical information on the subject. Symptoms that the piers were sinking, particularly the fourth from the Surrey side, were detected by the London County Council's engineers last autumn. It was decided to try to stop the subsidence by pumping concrete into the foundations, but this plan proved ineffective, as also did the driving of piles at the foot of the pier. As a last resort the bridge was closed and work begun on relieving it of some of its own weight. It appears that the weight of the bridge alone is much more serious an item in causing subsidence than that of the traffic passing over it. Thus on one of the piers the load due to the weight of the bridge structure is stated to be 11,000 tons, whereas the traffic load is only 500 tons. Since the bridge was closed about 1500 tons of material have been removed from the defective pier. When five or six hundred tons had been removed the subsidence ceased except for a rise and fall which very curiously accompanies the ebb and flow of the tide. The excessive weight of the bridge or the poor quality of the stone used in its construction is shown by the fact that after removal some of the stones in the arch were found to have developed signs of crushing. About 300ft. of the bridge has now been removed. It is the intention to make a temporary roadway across the gap so as to permit foot passengers to cross it again within the next three or four weeks. Two or three months thereafter it may be possible to reopen the bridge for vehicular traffic.

The Railway Shopmen's Strike.

THE many references we have, from time to time, made to the vexed question of the railway shopmen's bonus, have explained that many of the shopmen belong to the craft unions and not to the National Union of Railwaymen. These other unions have been jealous of the latter and have handicapped the National Union of Railwaymen in its negotiations with the railway companies concerning the shopmen. A possible result of this fact has been that the National Union has lost some of its enthusiam for the shopmen's cause, and has, as a consequence, given offence to the more advanced members of that grade. Their dissatisfaction with the attitude of the officials of the National Union of Railwaymen led these men to take independent action and to approach the London Electric Railways and the Great Western Railway for an advance of 10s. per week, a minimum of £3 per week, the consolidation of the war bonus of 16s. 6d. into their wages, a guaranteed day and week and a week's holiday with payment. The companies declined to consider any such application unless it came through the recognised channels, and the men thereupon called a strike, which commenced at midnight on Wednesday, the 4th. The result was sufficient to cause considerable inconvenience on the Underground on the three last days of the week, but this effect was mainly due to a sympathetic strike of some of the operating staff. The company at once closed one half of its stations and thus saved power by having fewer passengers to carry, by trains not having to stop and start so frequently, and by not having lifts to work. This arrangement offset, too, the absence of the staff. On the Great Western there was little, if any, interference with the traffic. Later, there was some trouble with the shopmen in the Great Northern and Great Central areas. The National Union was quick to recognise that its authority was being challenged, and on Wednesday Mr. Cramp addressed the men in very firm tones.

Low-temperature Carbonisation.

AN arrangement has just been entered into between the Nottingham Corporation and the Low-Temperature Carbonisation Company, under which the town will take the gas produced by a plant to be put up by the company in conjunction with the Digby Colliery Company. At the outset the installation is to be made capable of handling 1000 tons of coal a day, and it is intended to produce 250,000 tons of smokeless fuel a year. The gas produced will amount to some 700 million cubic feet a year, while there will also be available 7,000,000 gallons of crude oil and 1,000,000 of motor spirit.

Imperial Airways.

CONFIDENCE in the financial status of Imperial Airways seems to be implied by the fact that the subscription list in connection with the issue of 500,000 shares of £1 each—half the company's authorised capital—was issued on Thursday morning of last week and was closed on the afternoon of the day following. The shares are to bear interest at the rate of 10 per cent. per annum. Behind the company's financial position is the Government's assistance to the extent of a million pounds spread over a period of ten years. This sum may seem a large one, but as the minimum mileage to be flown yearly in order to earn it is one million miles, the Government's subsidy amounts to only 2s. per machine mile. The company has taken over the Handley Page, Daimler Hire, Instone and British Marine Air Services at a purchase price of £148,750. It is free to accept subsidies from foreign Governments and contemplates doing so.

Army Tanks and Tractors.

THE annual visit of the King and Queen to Aldershot on Saturday last proved an occasion of particular interest on account of the part played in the Army manœuvres by the latest type of military tank. During the day their Majesties had an opportunity of inspecting a Vickers tank similar in design to those which took part in the mimic action that was fought. The chief improvements which have been made since the war include a new type of shock absorbing device for the caterpillar tracks, increased armour protection and armament, and more roomy and convenient space for the crew working the machine. The armament now includes, we learn, one three-pounder gun, four Hotchkiss and two Vickers guns, which are placed in the turret in such a manner as to command every direction of fire. For its power the new tractor is comparatively light in weight, and the motors fitted to it are designed for a speed of about 25 miles per hour on a level road. The excellent manœuvring capabilities of the new type were demonstrated. Another interesting development was the use of the Dragon type of military tractor instead of horses, for drawing field artillery. This type of machine is also propelled by caterpillar tracks, and it is low in build, with a weight when light of about 4½ tons. In addition to hauling the guns, provision is made for carrying gunners and ammunition. The development, which has recently been made in tanks and tractors, was referred to, it may be recalled, in a lecture on "Progress of Mechanical Engineering in the Military Services," which was given before the Institution of Mechanical Engineers, by Major G. Le Q. Martel, on January 25th last, and which appeared in abstract form in THE ENGINEER for February 1st of this year.

Threatened Trouble by Railway Enginemen.

THE Associated Society of Locomotive Engineers and Firemen having succeeded, on January 29th last, in getting the railway companies to modify an award to which the Society's own representative had affixed his signature, is now anxious further to amend that award. The modification already made related to drivers engaged in shunting work being paid less than men on main line duties. Under the agreement made when the eight hours' day was introduced, all drivers were paid the same wage, but the award of the National Wages Board was that shunting drivers should be paid less. There has been some delay in carrying out this arrangement because of the difficulty in determining what qualified a driver, normally rated as a shunting driver, to be paid for main line work. The companies, recognising this difficulty, conceded a point that at once removed the cause of the delay. The new trouble over the award arises from the fact that the men are no longer being given a full day's pay if they are called upon to work on a Sunday; they are, however, paid a minimum of half a-day's wage. The companies' statement says, on this particular point, that as a result of representations put forward they have made every endeavour to restrict the number of occasions on which enginemen are called out for any turn of duty on Sunday which does not secure to them a full day's pay or for two short turns of duty on one Sunday. At the annual meeting of the delegates of the Associated Society last week, a letter was sent to the general managers demanding a settlement of all the alleged grievances. To this letter the companies replied last Friday that such procedure would not only be a departure from the unanimous award of the Wages Board, on which the Society was represented, but a breach of the strike settlement last January.

Pulverised Coal.

SOME particulars have just been published concerning a new pulverised coal plant which has been installed in the Union Electric Light and Power Company's station at Cahokia. Although detailed test figures are not yet available, the results of six months' running are said to be highly satisfactory. The local coal used is of a very inferior quality, but in burning it no troubles have been experienced. The pulverised coal plant has been built in accordance with the latest "Lopulco" methods, a self-contained vertical dryer, pulveriser, separator, pulverised coal bunker, feeders and burners being placed in front of each boiler. The new vertical dryers only use the chimney gases. On account of the fact that the coal used is purchased at low rates, no economisers have been installed. The ultimate capacity of the station will be 300,000 kilowatts, but at present the total output of the plant is only 60,000 kilowatts.

New Motorships for the Clyde.

IN our last issue we gave an account of the excellent results achieved by the motor ship Dolius on her maiden voyage. So satisfactory are these results that her owners, Alfred Holt and Co., of Liverpool, have placed with Scott's Shipbuilding and Engineering Company, Limited, of Greenock, an order for a larger vessel, which will also be propelled by twin-screw engines of the Scott-Still type. The new vessel, we are informed, will have a length of about 425ft., and her engines will be designed to develop about 4000 horse-power. Another Greenock firm, John G. Kincaid and Co., Limited, has secured the machinery orders for two twin-screw motor tankers, which are to be built by the Blythswood Shipbuilding Company, Limited, Scotstoun, for Norwegian owners. These engines will be of the Burmeister and Wain type, which Messrs. Kincaid build under licence from Harland and Wolff, Limited. The new orders will form part of eight sets of Diesel machinery which the firm now has in hand.

The British Empire Exhibition.

ENGINEERING EXHIBITS, No. VIII.*

GENERAL ENGINEERING EXHIBITS.

R. AND W. HAWTHORN, LESLIE AND CO., LIMITED.

R. AND W. HAWTHORN, LESLIE AND CO., Limited, of Newcastle-upon-Tyne, have two stands in the Palace of Engineering. On one, besides numerous models of ships and marine engines, are shown two model locomotives made to the same scale. One of these models represents the Comet, an engine built by the firm for the opening of the Newcastle and Carlisle Railway in 1835. The other model is of a Caledonian locomotive constructed in 1915. The two are put side by side to show the striking advance that was made in locomotive design in the relatively short period of eighty years. The Comet, which was a very famous engine, but not to be confounded with Stephenson's locomotive of the same name, was illustrated and described in our issue of July 14th, 1922—"Short Histories of Famous Firms." It was in many respects ahead of its time, and was remarkable for the fact that it had inside cylinders inclined upwards so that the piston-rods might pass underneath the front axle. The pistons were 12in. in diameter, and had a stroke of 16in. The wheels, four in number, were coupled, and they were 48in. in diameter. The boiler was tubular, 7ft. 6in. long and 3ft. in diameter, and the grate area was 6.4 square feet. The working pressure was 60 lb. The really striking feature about the engine was the use of four fixed excentrics, instead of two loose excentrics, as then generally employed.

On the other stand of R. and W. Hawthorn, Leslie and Co., Limited, there are a locomotive steam crane and a small electric battery locomotive, made to Captain Durtnall's patents. It is interesting to recall that the firm has been interested in steam cranes from very early years, and that the particular from of locomotive crane which it makes has been used for more than a quarter of a century. The illustration which we give on this page, Fig. 167, and on page 648 will recall the type at once to the memory. In the example exhibited, which is for the standard British gauge, the engine is of the 0–4–0 type, and has two outside cylinders, 14in. by 20in., driving 3ft. 4in. wheels. The total weight is 40 tons. The characteristic of the crane portion is that the load is raised by the direct action of steam upon a large piston coupled to the short arm of the jib, no tackle of any kind being employed. When not in use, the jib lies fore and aft, and rests on the chimney top, but when in use it can be swung in a complete circle by a slewing engine. Three hooks are provided. The first at a radius of 12ft. lifts 7 tons, the second at 16ft. 5 tons and the third at 22ft. 3¼ tons. The weight of the engine is such that it remains perfectly stable with these loads in any position. Whilst a crane of the kind has perfectly obvious limitations, it has great merits for certain classes of work, and since the engine itself may be used for shunting purposes, the general value of the arrangement for many services is considerable.

The storage battery locomotive presents a new solution of an old problem. The system is that known as the Paragon B. & B., and is notable for the fact that no contactors are employed, and that whilst resistances are not used, the control is effected at low voltage, so that the tendency to flash-over is materially reduced. Furthermore, braking is done by the regenerative method, the energy recovered being returned to the battery. We illustrate this locomotive by Fig. 166 and a drawing, on page 648. Leaving the electrical arrangements for the moment, we complete the description of the mechanical part. The motor is mounted between the frames, and drives one of the axles through reducing gear and a worm and wheel, giving a fixed reduction of 1 to 20. A cardan shaft is interposed between the motor and the worm to allow for the movement of the axle against the springs, whilst the motor is rigidly fixed to the frames, and thus escapes a great deal of vibration. All the bearings in this mechanism are of the ball type (Skefko). The gauge of the wheels, which are 3ft. 3in. diameter, is 4ft. 8½in., and the wheel base is 7ft. The weight in full working order is 15.6 tons. On a one hour rating, the motor develops 50 horse-power, and at the starting speed of something less than 3 miles per hour gives a tractive force of 5545 lb. The maximum speed for which the locomotive is designed is 8.5 miles per hour.

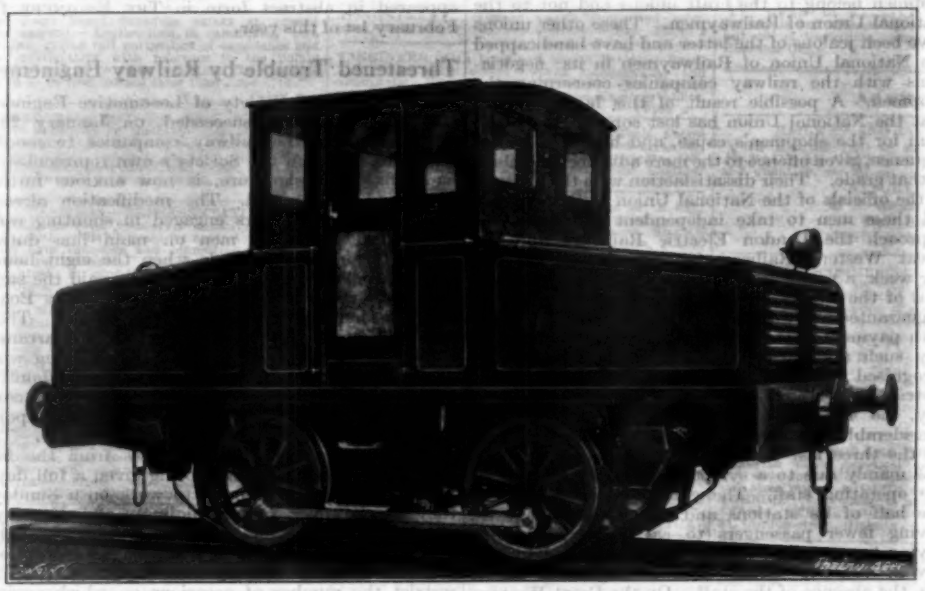


FIG. 166—ELECTRIC BATTERY LOCOMOTIVE—HAWTHORN, LESLIE

The control provides for eighteen efficient speeds in either direction, and is effected by a variable voltage system designed by Captain W. P. Durtnall, to whom we are indebted for the following particulars. The machine used for varying the voltage applied to the main traction motor and for controlling the current when the battery is being charged is called by the inventor an "electro-kinetic transformer," and consists of two direct-current machines with the armatures connected in series and mechanically coupled. The revolving parts are designed to give a considerable fly-wheel effect, so as to avoid heavy peak loads on the battery. This transformer can give a boosting voltage in either direction, the result being that with a pressure of 192 volts across the battery, a voltage varying from zero to 440 can be applied to the main traction motor.

When the transformer has been started, the locomotive is controlled by an eighteen-point speed controller, which gradually increases the speed of the engine in eighteen steps, until it attains the full running speed, namely 6½ miles per hour. There is also a foot pedal which enables the driver to obtain a still higher speed when the engine is making a journey without trucks. The general principle of the control system will be understood from the diagram, Fig. 168. The field windings of the machines A and B and those of the main traction motor are connected across the battery, and, as shown in the diagram, the traction motor, which runs at a maximum speed of 1000 revolutions per minute, is included in a closed circuit indicated by the thick lines. By turning the controller handle, which cuts out resistance in one of the machines belonging to the transformer and inserts resistance in the field of the other machine, the locomotive speed is gradually increased, and owing to the kinetic energy stored in the moving parts of the transformer, heavy peak loads on the battery are avoided. When slowing down or when stopping the engine, the traction motor, having separately excited shunt characteristics, acts as a generator, and returns current through the transformer to the battery, the regenerated current being, thereby, changed from relatively high-pressure current into a heavier low voltage current, which is supplied to the cells.

The locomotive is reversed by changing the armature connections of the main motor by means of the reversing lever.

When charging from a 440-volt direct-current supply, the battery is connected, as shown in Fig. 169, and owing to the possibility of introducing an opposing voltage into the circuit by means of the transformer, it is permissible to charge the cells from circuits ranging from 50 to 500 volts without the use of charging resistances or a separate motor generator set. This, Captain Durtnall points out, is a great advantage, especially in view of the fact that current drawn from the outers of a three-wire system is generally sold at relatively cheap rates.

When it is desired to charge the cells, the necessary alterations in the connections are made by placing the locomotive reversing lever in the neutral notch of the quadrant. The charging plug is then placed in the receptacle, and when the charging voltage has been made equal to the battery voltage by manipulating the eighteen-point controller, the charging switch is closed and the requisite current is put into the cells.

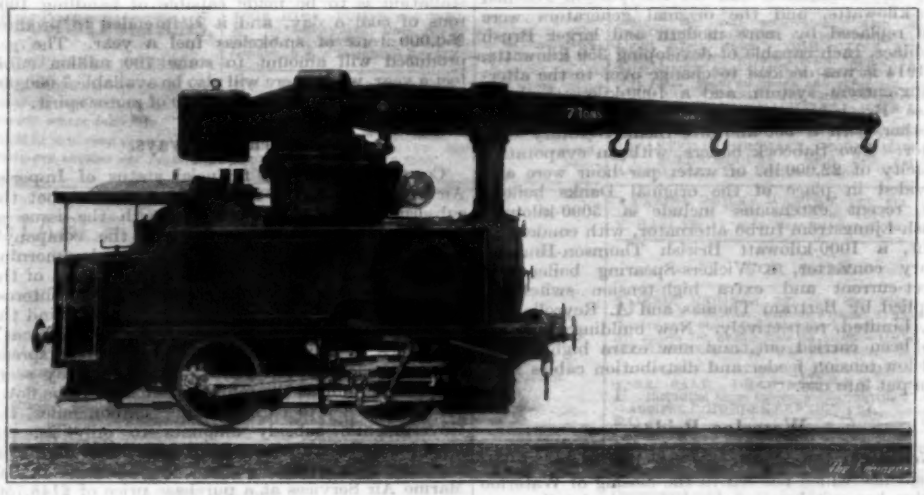


FIG. 167—LOCOMOTIVE STEAM CRANE—HAWTHORN, LESLIE

These locomotives can also be built so that they can be charged from a single-phase or polyphase supply, as well as from a direct-current supply. In this case, the fly-wheel between the two machines which constitute the "electro-kinetic transformer," would be constructed in the form of a squirrel-cage rotor, and a stator surrounding the rotor would receive the alternating current, the transformer being run up to speed with direct current in the ordinary way.

The foot pedal to which we have alluded gives an increase in locomotive speed of 50 per cent. If this

* No. VII. appeared June 6th

speed were brought about entirely by weakening the field of the main traction motor, bad commutation would result, and in order to avoid any trouble in this direction the field of the motor is only weakened sufficiently to give half the total increase in speed, the remainder of the speed regulation being obtained by weakening the field belonging to one of the machines which constitute the transformer. The impressed voltage consequently rises, and a 50 per cent. increase in speed is attained without making the traction motor field unstable.

One of the principal advantages claimed for this system of control is that as kinetic energy is given up by the transformer when starting, &c., the battery is not subjected to heavy peak loads. These loads, as much as 150 ampères. The total weight of the locomotive is 15 tons, and all this weight is on the driving wheels. With the controller on No. 2 contact, corresponding to one-ninth of the full locomotive speed, the wheels were made very gently to skid against the upturned ends of the rails on which the engine is mounted, thus demonstrating the ability of the locomotive to give a high tractive effort. We are told that before the engine left the works it was run on a 1 in 13 test gradient, and with the controller on the ninth notch, corresponding to 3½ miles per hour, the energy consumption was 100 ampères at 192 volts. At the top of the gradient the locomotive was reversed, and it ran down the gradient at the same speed, and with the controller in the original position.

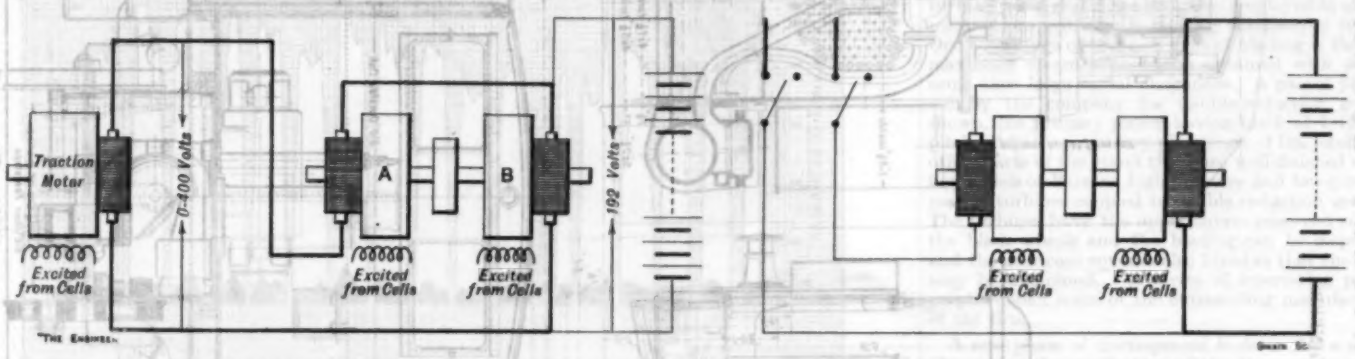


FIG. 169—SPEED CONTROL SYSTEM

FIG. 169—CONNECTIONS FOR CHARGING

Captain Durtnall points out, not only lower the discharge efficiency of a battery, but they also tend to buckle the plates. The system also permits of a higher gear ratio than usual, and consequently a higher speed, and more efficient motor. The use of a 4 to 1 gear ratio, as generally employed on low-speed locomotives, necessitates the employment of a relatively large and heavy slow-speed motor, with a lower efficiency. On these Paragon locomotives high-speed motors are always used. The transformer runs at a speed of 1500 revolutions per minute.

It is claimed that with this regenerative system of control there is a saving in battery capacity of no less than 40 per cent. This saving is brought about by the absence of resistance losses, the high efficiency of the motor and the saving which results from the regenerated current when it is put into the cells on down gradients and during the stopping periods. Although it would appear that the initial cost of a locomotive fitted with this type of control equipment would be greater than that of one with the ordinary series parallel control system, such, we are told, is not the case. Captain Durtnall claims, in fact, that these engines can be built more cheaply than those constructed on orthodox lines.

During our visit to the maker's stand the locomotive was put under a full-load tractive effort test. Although the current drawn from the battery did not exceed 60 ampères at 192 volts, the low-voltage current delivered to the traction motor was In this case 40 ampères were returned to the cells, so that the net consumption on the up gradient was only 60 ampères. The battery, which was supplied by the D.P. Battery Company, of Bakewell, Derbyshire, is composed of ninety-six cells of the "Kathanode" type, with a capacity of 240 ampère-hours at the five-hour rate. The plates are in ebonite boxes, which are nested in groups in strong wooden containers.

The battery locomotive undoubtedly has a great field for certain classes of work, and it is a matter of interest to find a firm that has had long experience in the construction of steam locomotives taking up the manufacture of a battery engine, designed on unorthodox lines.

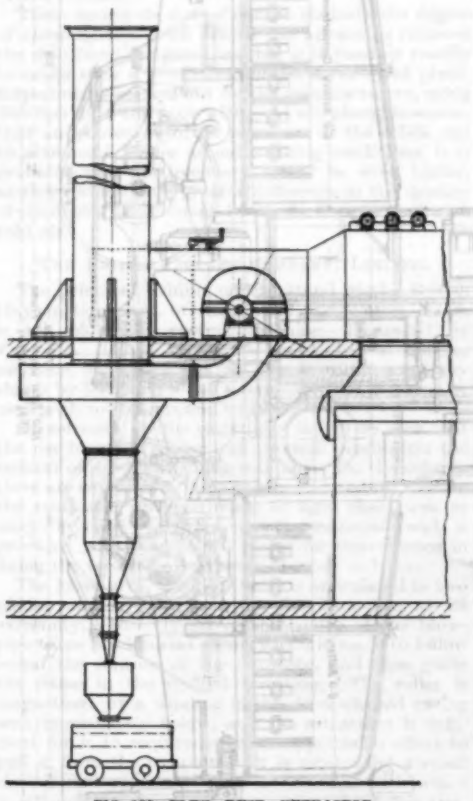


FIG. 170—FLUE DUST EXTRACTOR

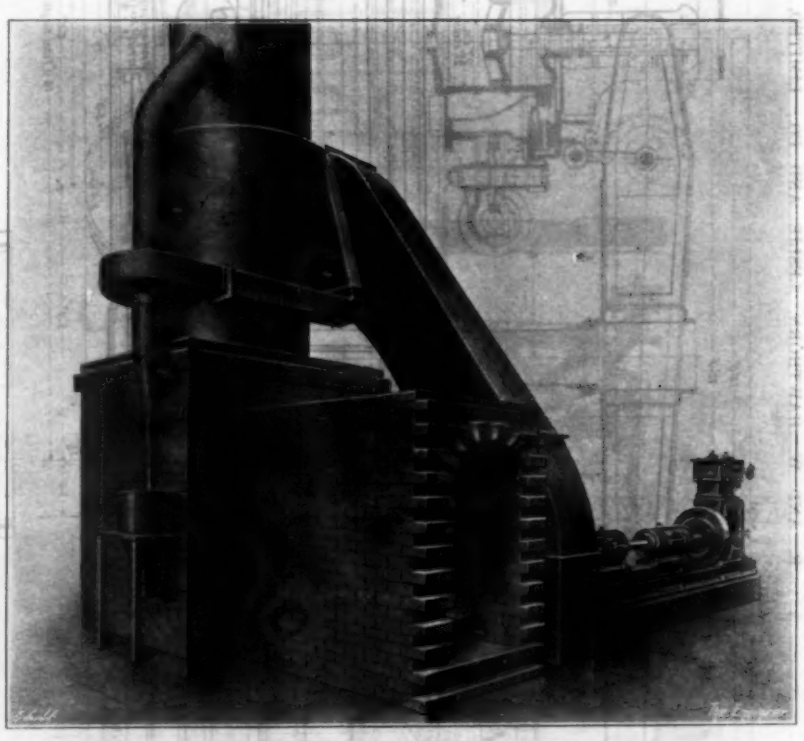


FIG. 171—FLUE DUST EXTRACTOR FOR BOILERS—DAVIDSON

DAVIDSON AND CO., LIMITED.

In our issue of May 2nd, in connection with the stand of Davidson and Co., Limited, Belfast, we made some reference to the cyclone dust extractor, manufactured by that firm, and gave some illustrations of it as an individual unit. We are now enabled to show the application of the device for the extraction of flue dust and grit from boiler gases and to give a diagram indicating the effectiveness of the apparatus.

In the case of new construction with steel chimneys, the arrangement shown in Fig. 170 is adopted. The stack, it will be seen, is supported on a structure with space below for the accommodation of the extractor, with, still further below, a way for the removal of the refuse.

The extractor works in conjunction with an induced draught fan, which sucks the gases from the main flue and discharges them tangentially into a large volute casing arranged immediately below the chimney. Beneath the volute there is a series of alternating truncated cones and cylinders, with a dust outlet at the bottom.

The smaller diameter of the volute terminates tangentially with the periphery of the first cone, with the result that the dust in the gases is gently guided into the cone, under the action of centrifugal force and gravity, while the clean gas forms a core in the centre, which escapes upwards, through a central opening, directly into the chimney.

In the case of existing chimney stacks, where it is not possible to dispose the grit collector below, as just described, the arrangement illustrated by Fig. 171 is adopted. Here the volute forms a muff round the base of the chimney, and into it the gases are driven tangentially by a fan, as in the other arrangement. An opening is made in the side of the chimney, naturally reinforced to make up for the material removed, to provide a passage for the gases from the volute to the interior of the stack.

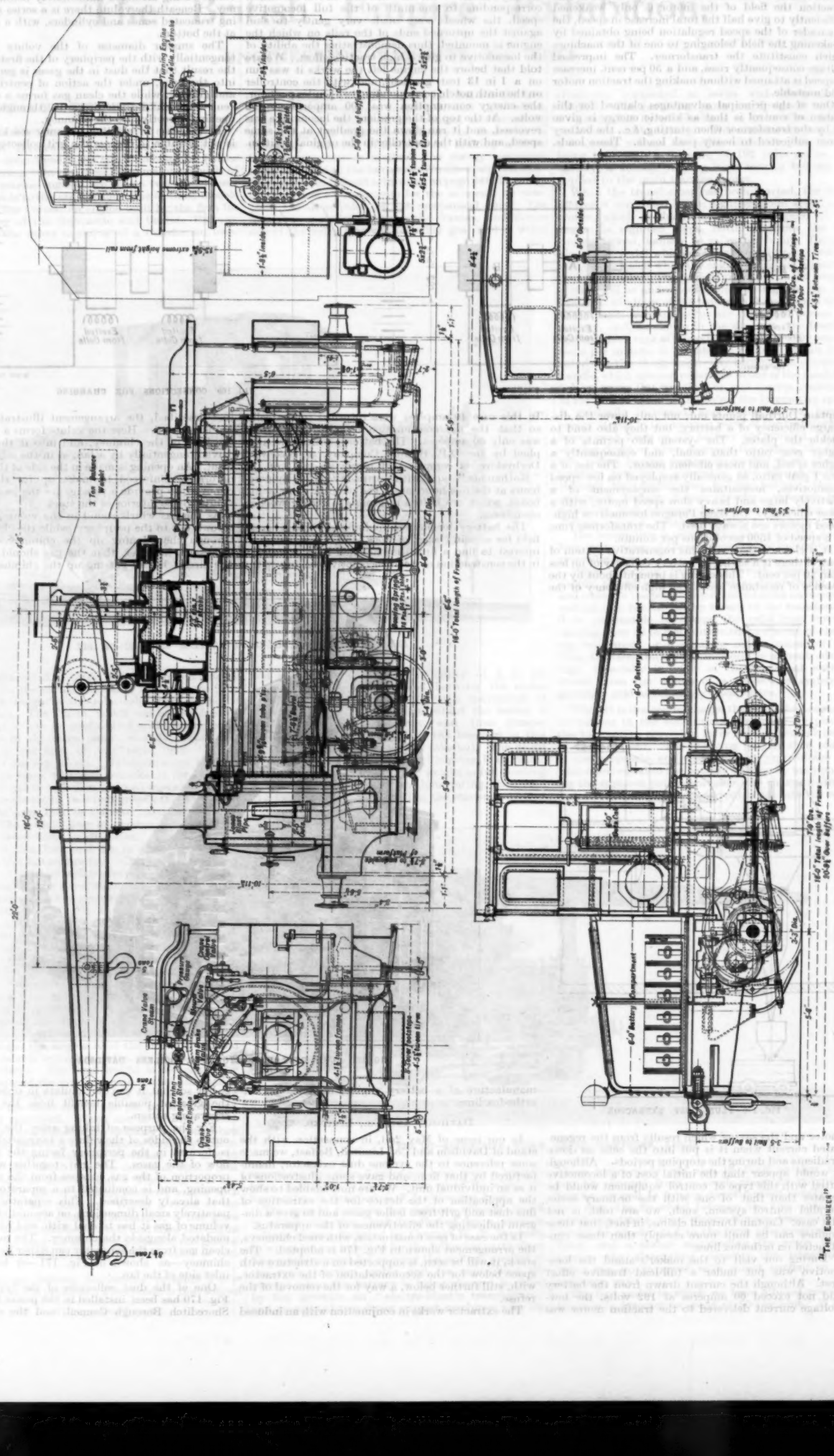
As the gas whirls round in the volute, the grit is thrown out to the periphery, while the clean gas goes through the opening up the chimney. It is not necessary, however, that the gas should make only one circuit before passing up the chimney, as space is left so that it can re-circulate in order to obtain the greatest possible benefit from the centrifugal separating action.

For the purpose of taking away the dust forced out to the sides of the volute a tangential slot, or lip, is formed in the periphery facing the direction of flow of the gases. The grit, together with a small proportion of the gas, escapes from the muff by this opening, and is conducted to a separator similar to that already described. This separator is of comparatively small dimensions, on account of the smaller volume of gas it has to deal with, and can be accommodated alongside the chimney. The outlet for the clean gas from the separator can either be led into the chimney—as shown in Fig. 171—or taken to the inlet side of the fan.

One of the dust collectors of the type shown in Fig. 170 has been installed in the power house of the Shoreditch Borough Council, and the chart repro-

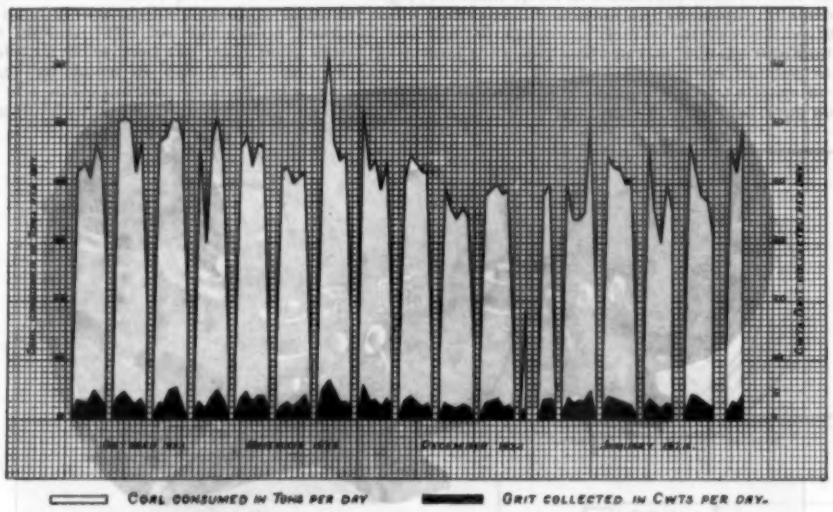
EMPIRE EXHIBITION—LOCOMOTIVE STEAM CRANE AND BATTERY LOCOMOTIVE

R. AND W. HAWTHORN, LESLIE AND CO., LIMITED, NEWCASTLE-UPON-TYNE, ENGINEERS


Turning Engine
Cylinders 6 dia. x 6 stroke
Crane Valve Steam
Crane Valve Water
Pressure Gauge
Steam Valve
Water Valve
Turning Engine Steam
Turning Engine
Crane Valve
Driving Spring
Driving Axle
Trailing Axle
Trailing Spring
Total length of Frame
Total length of Buffers
Cab
Battery Compartment
Battery
Total length of Frame
Total length of Buffers
Over Footplate
Over Cab
Over Buffers
Total length of Buffers
Total length of Frame
Over Buffers
Over Cab
Over Footplate

duced in Fig. 172 has been prepared by Mr. C. Newton Russell, chief electrical engineer to the Council, with the object of showing the efficacy of the apparatus.

The chimney with which the collector has been connected serves two Stirling boilers, each capable of evaporating normally 33,000 lb. of water per hour from and at 212 deg. Fah. The boilers are fitted with chain grate stokers, each having an area of 168 square feet, and forced draught is supplied in the usual manner. There are Green's economisers above the boilers and Sirocco fans for the induced draught. The dust collector is arranged as shown in the drawing, Fig. 170.



COAL CONSUMED IN TONS PER DAY — GRIT COLLECTED IN CWTS PER DAY.

FIG. 172—EFFECT OF DAVIDSON FLUE DUST EXTRACTOR

The total amount of coal consumed by the two boilers during the four months represented in the graph, Fig. 172, amounted to 3604 tons, consisting of 75 per cent. Leicestershire slack and 25 per cent. Scotch washed peas. During the same period the quantity of grit collected was 14 tons 15 cwt., which would otherwise have been discharged from the top of the chimney.

These figures do not, of course, indicate the degree of thoroughness with which the apparatus removes the dust from the gases, neither is it possible readily to make such a determination on a full-sized plant. Experiments carried out by the manufacturers, using fine flue dust and soot with cold air, show, however, that an extraction of 96 per cent. of the solids can be attained. Under actual working conditions, it is probable that the recovery would be even better, as there would be a greater difference in the density of the dust when compared with the hot gas than with cold air.

THE BRITISH OXYGEN COMPANY, LIMITED.

The principal exhibit on the stand of the British Oxygen Company, of Angel-road, Edmonton, N. 18, is the blow-pipe cutting machine—illustrated by Fig. 173. It is known as the Universal cutting machine, in view of the fact that it will cut out any shape by following round a template, and is generally used with town's gas and oxygen.

On reference to the engraving, it will be seen that the machine has a base and column, much after the fashion of a radial drilling machine. On the column there are two arms. The upper one is used for holding the template, which is made of light sheet iron or steel—it must be of magnetic material—and is provided with two slotted plates for convenience in fixing the templates by means of studs or bolts.

The lower arm, it will be seen, is articulated in two places, and is used to carry the blow-pipe at its extremity. Directly above the centre of the blow-pipe there is a knurled roller, which is made to follow round the contour of the template, and thus guide the flame in the desired direction. The roller is magnetised by a winding in the drum-shaped casing seen immediately below, and the attraction is sufficient for it to require quite an appreciable effort to pull it from the template. It is rotated by a small electric motor, mounted on the column, with which it is connected by shafting running along the arm. Bevel gears at the articulations provide for the movement of the arm.

It will be readily appreciated that this method of travelling the blow-pipe ensures that it will move at a uniform speed regardless of the direction of travel, so that an equally good cut is made all round any article, when once the speed of travel has been set properly.

The speed of travel naturally depends upon the thickness of metal being cut, so a change-speed gear-box is provided in the drive for the knurled roller. This box can be seen just below the motor, and is of the friction drive type. By means of three levers a very wide range of speed can be obtained, while one lever gives an instantaneous change from slow to fast, or *vice versâ*, without checking the travel. This arrangement is very convenient when cutting sections of various thicknesses, such as channels and angles, as the web can be cut quickly and the flanges at the proper—slower—speed.

There is a hand wheel at the bottom of the column for regulating the height of the arms according to the thickness of the work in hand, while there are fine adjustments on the blow-pipe itself. The arms can be swung round, out of the way, so that heavy pieces of work can be put on the table by means of a crane. It will be noticed that guards are provided for preventing the oxide coming from the cut splashing out into the shop, and there is a removable tray for catching the slag.

The machine exhibited on the stand has a table capable of accommodating pieces of work up to 4ft. by 2ft. 3in.

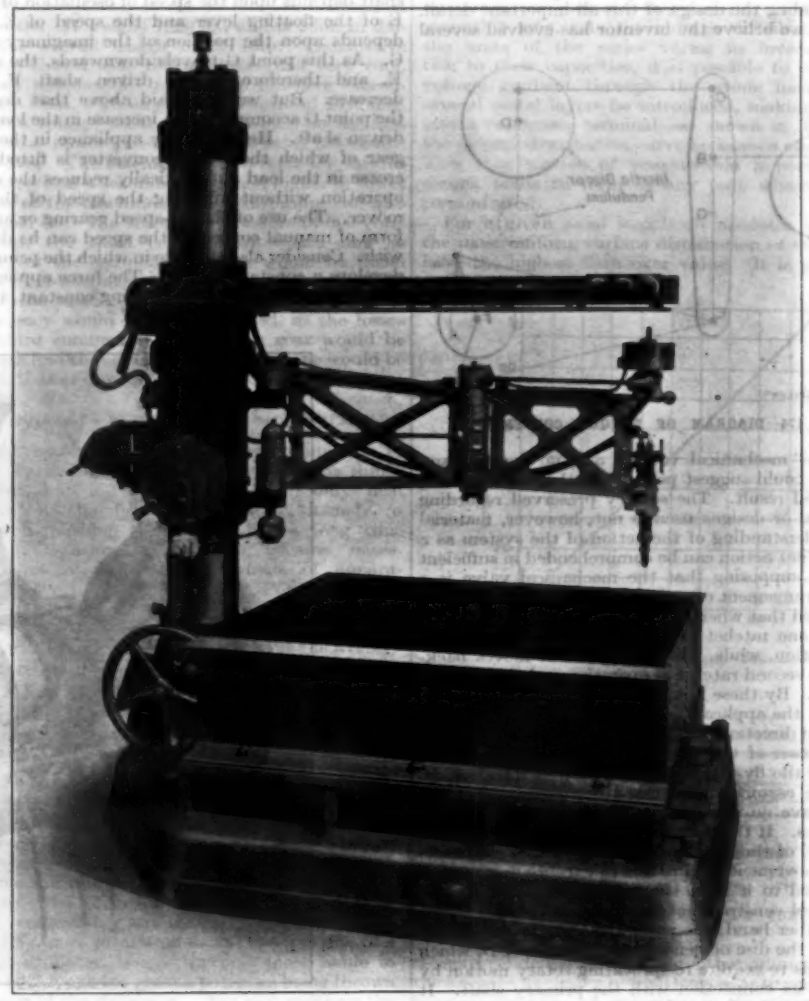


FIG. 173—BLOWPIPE CUTTING MACHINE—BRITISH OXYGEN COMPANY

THE PARSONS MARINE STEAM TURBINE COMPANY, LIMITED.

On the stand of the Parsons Marine Steam Turbine Company, Limited, of Turbinia Works, Wallsend-on-Tyne, is a series of exhibits showing the development which has taken place in recent years in connection with the application of geared turbine machinery to the propulsion of ships. Various shaft arrangements of single and double screw double-reduction geared turbine units are shown, and are illustrated by stationary and working models. An interesting exhibit is the gear wheel and the pinions taken from H.M. torpedo-boat destroyer Badger, which vessel was the first naval ship to be fitted with geared turbines. The wear on the gears is stated to be small, although the Badger was in service from 1912 to 1921, and during the time she was in commission steamed over 160,000 miles. Among other exhibits are specimens of "reaction type" and "end tightened" turbine blading. The last-named system of blading has been very largely adopted for land turbine work, and it has been also employed in marine installations, with, we learn, very satisfactory results. One advantage of this new type of blading is that the maximum steam economy is obtained with at the same time large radial clearances. A pair of pinions cut by the company for double-reduction gear is shown, the primary pinion having teeth of 7/12 inch pitch, while the secondary pinions are of 1in. pitch. On other parts of the stand there are well-finished working models of Parsons high-pressure and low-pressure marine turbines coupled to double-reduction gearing. The turbines have the upper covers removed so that the blade wheels and the blading can be inspected, and the gear case cover is also lifted so that the gears may be examined. A series of interesting photographs depict some of the outstanding manufactures of the firm.

A new phase of development is shown by a model illustrating the application of the Parsons geared oil engine system. It is proposed to use engines of the multi-unit four-stroke cycle type, running at a high speed. An enclosed type of heavy oil engine with forced lubrication is shown. The drive from each engine is transmitted to the propeller through an elastic frictional coupling, a friction clutch and reduction gearing. Heat is recovered from the cylinder jackets and the exhaust gases by allowing the water jackets to generate steam, and connecting these parts with a boiler heated by the exhaust gases from the engines. This system, it is claimed, possesses important advantages in that by the use of reduction gearing both the engine and the propeller run at their most efficient speeds, and the heat recovered from the jackets and exhaust gases may be used in the form of steam for driving auxiliary machinery or for heating the ship. The use of high-speed multi-cylinder engines is stated to give increased cargo-carrying space, as compared with marine oil engines of the ordinary

slow-running type coupled direct to the propeller. The system is illustrated by two models showing two and four units of the Parsons geared oil engine, respectively arranged for the propulsion of a single-screw ship.

G. CONSTANTINESCO.

The stand of Mr. G. Constantinesco, of 7, Grosvenor-gardens, London, S.W. 1, is devoted almost entirely to an exhibition of this well-known inventor's latest device, the Constantinesco torque converter. This appliance has been described as a practical illustration of the principle of relativity applied to the problem of automatic transmission of power, and its action has been explained by way of electrical analogy. There is, however, nothing mysterious about it, except what the inventor for the present chooses, or is compelled, to keep secret. It is a purely mechanical device for the transmission of power at variable speed, and makes use of well-known dynamical principles. It requires neither Einstein's doctrine nor electrical theory to make its mode of action comprehensible.

The diagram—Fig. 174—explains the principle on which this torque converter works. A is the shaft of a prime mover carrying a fly-wheel and crank. The crank is connected by a link to a point B on a lever. Another point C on this lever is linked to a crank on a shaft D provided with a fly-wheel, or, it may be, a simple pendulum, as indicated in dotted lines. A third point E on the lever is connected by two links to a double ratchet and pawl arrangement on a shaft F, forming the secondary or driven member of the combination. The object is to transmit power from A to F at variable speed.

It may be stated before attempting to explain the working of the system that the points B C E may divide the lever in any ratio, and that the point B may even lie beyond C or E. The lever has no fixed fulcrum. It should also be stated that secrecy is preserved regarding the construction of the ratchet and pawl arrangement on the secondary shaft. It is not an ordinary ratchet and pawl system. We are permitted to say only that it is a member of the family of which the ratchet is one of the lowest forms. By analogy with the thermionic valve, the inventor refers to it as a "mechanical valve," for it permits motion to take place in one direction and not in the other. These statements help us very little towards understanding the design of the all-important detail. Actually, we believe the inventor has evolved several

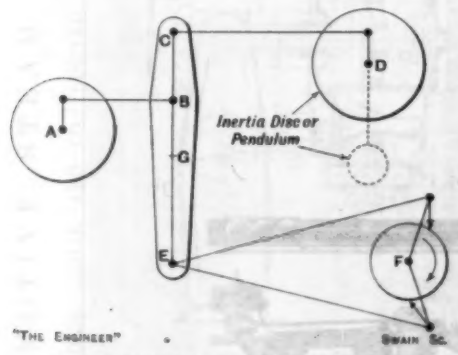


FIG. 174—DIAGRAM OF TORQUE CONVERTER

forms of "mechanical valve," and no doubt many engineers could suggest possible methods of effecting the desired result. The secrecy preserved regarding the design or designs used is not, however, material to an understanding of the action of the system as a whole. That action can be comprehended in sufficient detail by supposing that the mechanical valve is a simple arrangement of a ratchet wheel and two pawls, so designed that when the point E of the lever swings forward, one ratchet is operative and the second is out of action, while, when the point E moves backward, the second ratchet is operative and the first out of action. By these means the swinging of the lever results in the application of torque to the shaft F in a constant direction during both portions of the swing.

The action of the device depends entirely on the inertia of the fly-wheel or pendulum on the shaft D. Let it be assumed that the other members of the system have no inertia and that the arrangement is frictionless. If there be no load on the shaft F, then the end E of the floating lever experiences no resistance to movement, and is free to execute any motion contributed to it from the primary shaft under the geometrical constraint of the linkages of the system. On the other hand, the point C is constrained by the inertia of the disc or pendulum on the shaft D, which shaft tends to acquire reciprocating rotary motion by virtue of its connection with the primary shaft. It is clear that the faster the primary shaft rotates for the no-load condition of the secondary, the greater will be the inertia resistance preventing motion of the point C. In the extreme, the point C becomes a fixed fulcrum. The point E then swings to and fro with a motion which results in the rotation of the shaft F at a speed dependent upon the ratio of E C to B C and upon the design of the ratchet gear.

On the other hand, let the load on the secondary shaft become infinitely great. The point E then becomes the fixed fulcrum, and the point C oscillates with a velocity dependent upon the ratio of C E to B E, and upon the capacity of the prime mover driving the shaft A to overcome the inertia of the disc or pendulum on the shaft D.

In intermediate conditions the fulcrum point is somewhere between C and E, travelling downwards as the load on the shaft F increases.

It is quite impossible in the space at our disposal to discuss the results secured by this gear. They are many and varied. One of the most interesting can be briefly indicated. For the sake of simplicity, let it be supposed that the prime mover driving the shaft A runs at constant speed. The speed of the secondary shaft depends upon the speed of oscillation of the end E of the floating lever and the speed of E in turn depends upon the position of the imaginary fulcrum G. As this point G travels downwards, the speed of E, and therefore of the driven shaft F, clearly decrease. But we have said above that descent of the point G accompanies an increase in the load on the driven shaft. Hence, in any appliance in the driving gear of which the torque converter is fitted, an increase in the load automatically reduces the speed of operation without affecting the speed of the prime mover. The use of change-speed gearing or any other form of manual control of the speed can be dispensed with. Consider also the case in which the prime mover develops a constant torque. The force applied to the point B of the floating lever being constant, the force applied from the point E to the ratchet gear, and therefore the torque applied to the driven shaft, will depend upon the position of the fulcrum G. As the point G descends, the force transmitted from the point E clearly increases. But, as before, descent of the point G accompanies an increase of the load on the driven shaft. Hence, in a vehicle or other machine fitted with the torque converter, a powerful starting torque is automatically obtained without overloading the prime mover and wasting energy.

At the Exhibition the device is shown in a variety of model forms, and as developed for practical application to a small light car having a single-cylinder engine of a nominal 4 horse-power and running at 2000 to 3000 revolutions per minute. In the course of a few weeks, we understand, the converter will be shown applied to a locomotive driven by an 800 horse-power Beardmore oil engine.

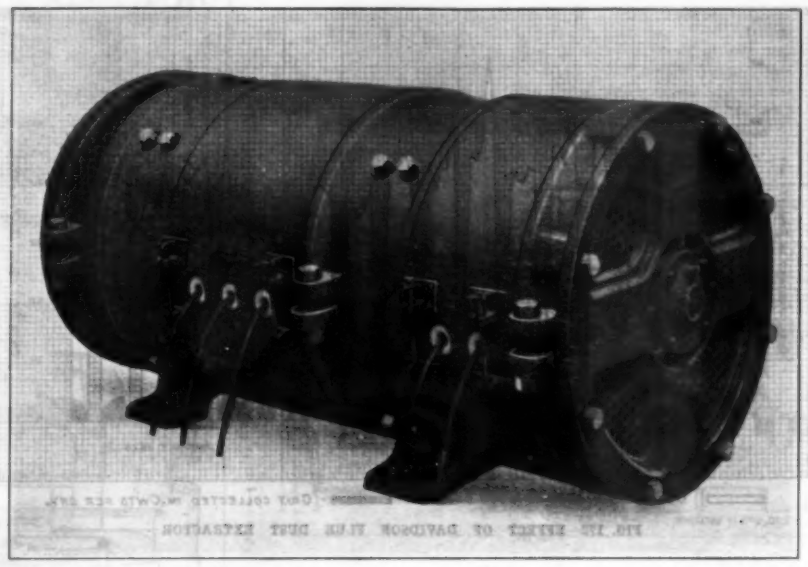


FIG. 175—SELF-REGULATING MOTOR GENERATOR—BRITISH THOMSON-HOUSTON

ELECTRICAL ENGINEERING EXHIBITS.

THE BRITISH THOMSON-HOUSTON COMPANY.

The machine shown in Figs. 175 and 176 is a new self-regulating motor generator for use on electric trains, and it is being exhibited by the British Thomson-Houston Company, Rugby. It provides the current necessary for lighting and heating, and for the control circuits for operating the contactors, reversers and circuit breakers, &c., on locomotives of multiple-unit electric trains drawing current at a high voltage from collector rails or overhead wires. On account of the voltage fluctuations which occur on high-pressure traction supply systems, it is difficult to design a machine which will provide current at a low steady voltage suitable for lighting purposes, but all these difficulties have been overcome by the British Thomson-Houston Company's traction engineers. The machine acts partly as a genemotor or dynamotor. Its magnetic circuits are so arranged that the voltage regulation is independent of the load on the set, notwithstanding that there is no external regulator. The steel magnet frame is divided on the horizontal axis and hinges on one side enable the top half of the frame to be opened, as shown in Fig. 176,

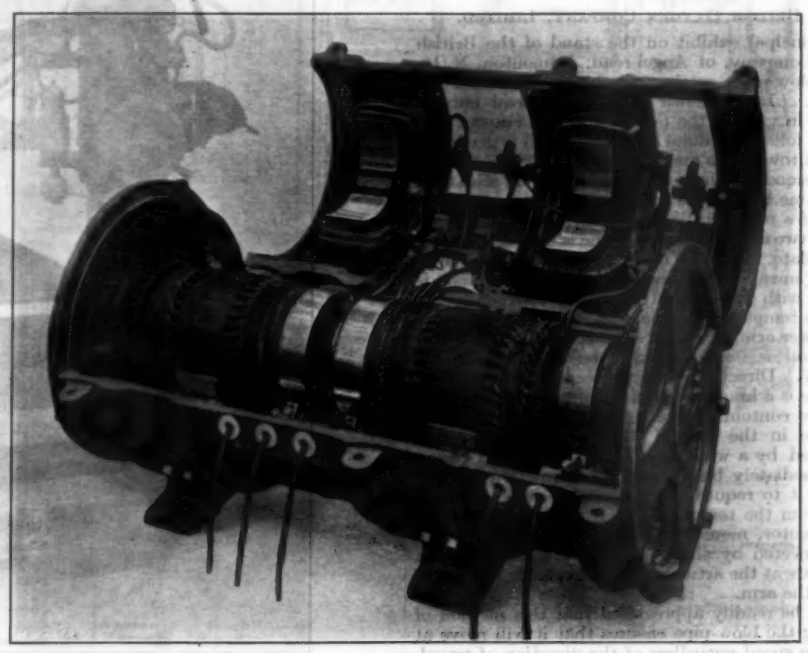


FIG. 176—MOTOR GENERATOR WITH COVER LIFTED—BRITISH THOMSON-HOUSTON

without interfering with the internal connections.

Each armature revolves in its own field system. One of the armatures has a single winding and works as a low saturation machine, the normal working flux being on the straight part of the H-B curve, whilst the other armature has two windings and two commutators, and with its field system it works as a high saturation machine—that is to say, the normal flux is on the saturated part of the curve. The second winding of this armature generates the low voltage, and it is, of course, entirely separate from the high-voltage circuit. The low saturation machine has commutating poles, and the main poles carry three windings—as shown in Fig. 177. These windings consist of a series starting winding (*a*) a main shunt winding (*b*), excited by the low saturating armature, and a bucking shunt winding (*c*) excited by the high saturation armature.

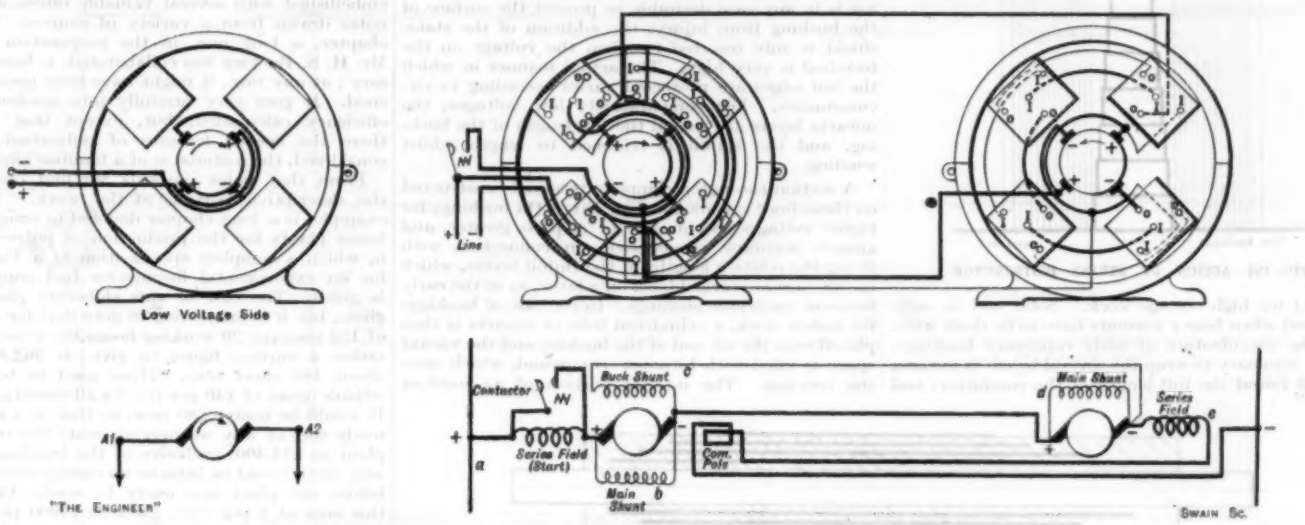


FIG. 177—CONNECTIONS OF SELF-REGULATING MOTOR GENERATOR—BRITISH THOMSON-HOUSTON

As the armature of the high saturation machine has two sets of windings, no commutating poles are fitted to this machine, for the armature reaction of one winding tends to balance that of the other winding. The main poles have two windings—a main shunt winding *d* excited by the high saturation armature, and a series winding *e* carrying the high voltage line current. On the low saturation machine the series starting winding *a* increases the starting torque, and when the low voltage reaches a predetermined value this winding is short-circuited by a contactor, the operating coil of which is energised by the low-voltage armature. The main shunt field *b* over-excites the poles, and at full load and normal volts on the line it is assisted by the bucking shunt *c*, so that the resultant field of these two windings corresponds

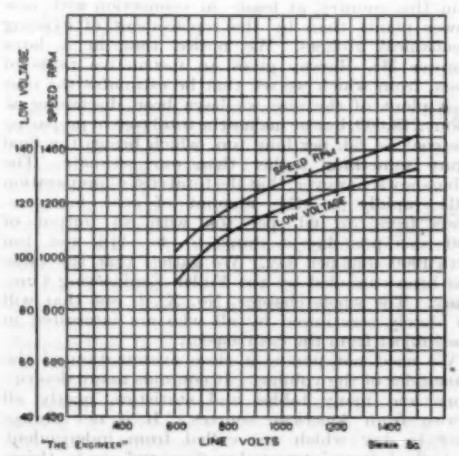


FIG. 178—SPEED AND VOLTAGE CURVES

with that required under normal working conditions.

On the high saturation end of the machine the series winding also helps to increase the starting torque. Under normal working conditions, it increases the saturation considerably, and maintains the flux when the load comes on or when the line volts diminish. It is on account of this tendency to keep the high saturation machine saturated that the steady operation of the set depends. If a change in the line volts occurs, then as the back electromotive force of the highly saturated machine can only alter very slightly, the variation is dealt with by the low saturation armature; but since the low saturation main shunt flux varies with the volts across the low saturation armature, the speed of the machine will only vary a small percentage, as compared with the percentage change in the line volts. In order to keep the speed still more nearly constant, the bucking shunt winding is provided, and as this winding is connected across the high saturation armature, it maintains a substantially constant flux at all voltages.

If the low saturation main shunt flux decreases with the line voltage, the difference between it and the bucking shunt flux will be still further decreased, thereby keeping the speed higher, so that the total drop in speed is less than it would be in the absence of the bucking shunt winding. The generator windings are therefore kept rotating at an approximately constant speed in a constant field, so that the output volts remain substantially constant. If the load falls the voltage across the low saturation armature rises, and the speed tends to rise, but the resultant ampère turns, and therefore the flux on the low saturation machine, is increased, so that the change in speed is reduced, and the speed is therefore kept more constant than it would be if there was no bucking field.

The machine shown at the Exhibition is rated at 10 kilowatts. It weighs 1520 lb., and is 23in. in diameter, the overall length being 46in. Exhaustive tests have shown that the machine runs very cool, the steady temperature under load nowhere exceeding 39 deg. Cent. with an air temperature of 15.5 deg. Cent. The voltage fluctuations obtained on the first experimental motor generator constructed are shown in Fig. 178. The machines can be built for various line voltages and a secondary voltage, higher or lower than that of the machine at the Exhibition, can also be arranged for. If a secondary pressure of 600 volts be needed, the third commutator would not be required, for the secondary voltage would be taken from the high saturation commutator and the overall length of the machine would, of course, be reduced. The efficiency would also be increased, as the losses on the third commutator and brush gear would be eliminated, and the operation of the machine would be similar to that of a reducer set.

METROPOLITAN-VICKERS ELECTRICAL COMPANY.

The Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester, is showing many things of interest, but in this issue we shall only deal with one of the firm's productions, namely, a 110,000-volt bushing insulator. For a long time after high transmission voltages became necessary, the insulation on the terminals of apparatus was the limiting factor. Porcelain had been used almost exclusively for insulating conductors where they passed through the earthed covers of transformers and other apparatus, but the average voltage per unit of radial thickness on any insulator decreases as the total thickness increases. For really high-voltage work, the thickness of porcelain necessary would be very great. Hollow porcelain bushings are filled with bitumen, paraffin wax or some similar dielectric. When, however, two or more dielectrics are used in this manner, they constitute in effect condensers in series, and the voltage drop across each of these condensers is proportional to the capacities. In designing compound condensers of this type, therefore, care has to be taken to proportion the thickness of each dielectric so as properly to distribute the voltage drop across them, in order to avoid overstressing any portion.

By adding more insulation to any one portion of a compound insulator, it may become more liable to breakdown, through too great a potential being thrown on one layer of the dielectric. For high voltages the compound insulator has a large diameter, irrespective of the kind of dielectric that is used. Moreover, there are considerable manufacturing difficulties in the way of filling the porcelain shell in order completely to exclude air bubbles and layers. It is true that air is deliberately used in certain types of insulators, but it cannot be considered to be a desirable insulating medium. Unless there is a constant movement of the air, it becomes ionised, when its good insulating properties are destroyed. The most widely used compound insulator is the oil-filled type. The outer shell may either be composed of a moulded fibrous material or it may be made of porcelain. Ordinary transformer oil is used, and a glass chamber at the upper end ensures that the whole interior of the insulator is filled. The oil filled insulator can be made somewhat smaller in diameter than other compound insulators, which are filled with semi-solid dielectrics, but they have certain disadvantages to which we need not allude.

Some years ago, the Westinghouse Company—now the Metropolitan-Vickers Electrical Company—introduced the condenser bushing, which has formed a prominent feature of the company's high-voltage apparatus ever since. On the conductor layers of micarta are wound, and at appropriate intervals during the winding process a layer of tinfoil is introduced. There are therefore several condensers in series between the conductor and the earthed mounting ring. As the voltage distribution across the units of the series varies in inverse proportion to their capacities, it is possible to control the voltage gradient through the whole insulator. If several metal layers be introduced, making the tube into a condenser terminal—as shown in Fig. 179—the voltage distribution curve becomes a straight line. This is a matter of considerable importance, for corona tends to form at any part where stress is concentrated.

For a given axial length an insulator which has the most uniform surface distribution of voltage will have the highest flash over value. It is possible to

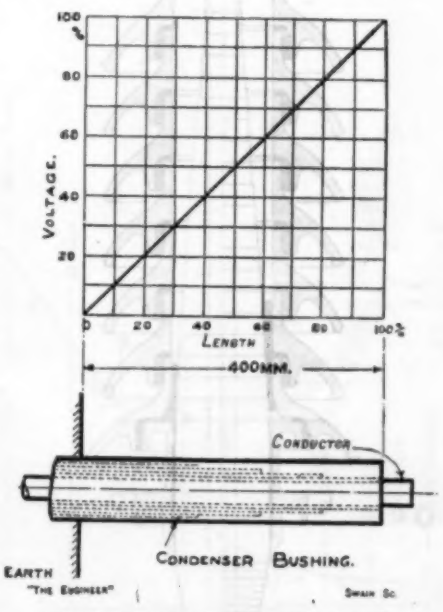


FIG. 179—VOLTAGE DISTRIBUTION CURVE

design a condenser terminal for either minimum radial thickness or minimum overall length, or to compromise between the two. A reduction in the diameter of a through terminal is desirable, not only because of the saving of space which may facilitate the design of the apparatus, but also because the accuracy of ring type series transformers mounted round the terminals is improved. For the sake of convenience in the manufacture of these bushings, the lengths of successive layers of tinfoil are decreased in arithmetical progression. Since the capacity between any pair of layers varies directly as the length and diameter of the foil, and inversely as the thickness of the micarta, and as the capacity of all layers must be

I

approximately equal, to obtain proper voltage stepping, the radial thickness of the micarta layers must vary. The central conductor is usually tubular, as this form of couductor gives mechanical rigidity and the small current-carrying capacity which is generally

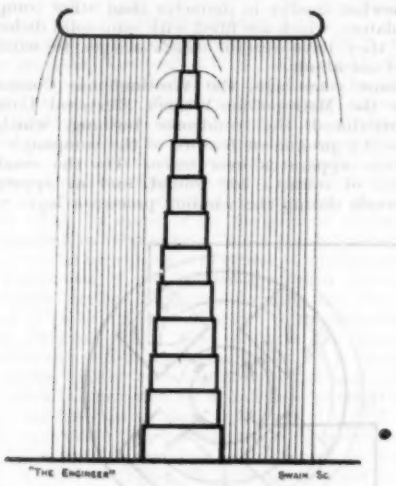


FIG. 180—ACTION OF STRESS DISTRIBUTOR

required for high-voltage work. Solid rod is only employed when heavy currents have to be dealt with.

In the manufacture of early condenser bushings, it was customary to wrap the several layers of micarta and foil round the full length of the conductor, and the successive layers of tinfoil were subsequently turned to the correct length. The micarta was cut away until the tinfoil showed, when the foil itself was carefully removed. In use, however, these insulators exhibited a tendency to develop corona at the edges of the foil, where they were exposed to the air. Some years ago, Messrs. Fortescue and Farnsworth showed in a paper read before the American Institute of Electrical Engineers how an insulator could be greatly improved by making its profile conform to the dielectric field. If the upper end of the conductor be surmounted by a large metal disc, the field will clear the dielectric of the terminals—as shown in Fig. 180—and in this way it will reduce local concentration which would ultimately cause a flash-over. The disc is usually termed a static shield or stress distributor.

If the disc could be made with a diameter sufficiently large, it would be sufficient to eliminate the trouble due to corona from the foil edges, and the final flash-over under test conditions would take place between the edge of the shield and earth. In practice, however, it is better to use a smaller shield and to seal in the edges of the foil with a dielectric stronger than air. This excludes the air and entirely prevents the formation of corona. Whenever corona is present, ozone and oxides of nitrogen are formed, and these attack and injure the micarta. Since some form of outer covering is in any case desirable to protect the surface of the bushing from injury, the addition of the static shield is only resorted to when the voltage on the terminal is very high. The actual manner in which the foil edges are protected varies according to circumstances. For comparatively low voltages, the micarta layers are wound the full length of the bushing, and the tinfoil is trimmed to length whilst winding.

A section through a complete terminal constructed on these lines is shown in Fig. 181. On bushings for higher voltages the number of steps is greater, and greater accuracy is necessary in connection with fixing the relative lengths of the tinfoil layers, which in this case are turned back on a lathe, as in the early forms of condenser bushings. In the case of bushings for indoor work, a cylindrical tube of micarta is then placed over the air end of the bushing and the vacant space is filled with bitumen compound, which seals the crevices. The interior portion of an outdoor terminal is the same as that for indoor work, but the outer micarta tube is replaced by one formed by several interlocking rain sheds, the spaces being filled with bitumen. The illustration, Fig. 182, shows a section of an outdoor terminal. The standard 66,000-volt indoor bushing flashes over under dry conditions at 220,000 volts, whilst an outdoor bushing was found to flash-over on a wet test at 155,000 volts. When the bushing is dry, no corona is visible at 165,000 volts, whilst when it is wet no corona is noticeable at 135,000 volts, except on the top metal bell.

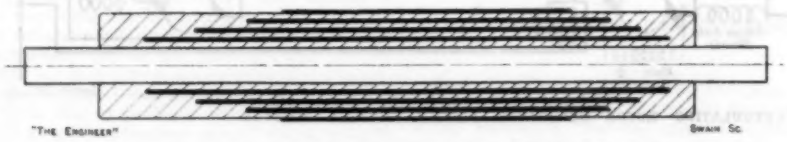


FIG. 181—SECTION THROUGH BUSHING INSULATOR—METROPOLITAN VICKERS

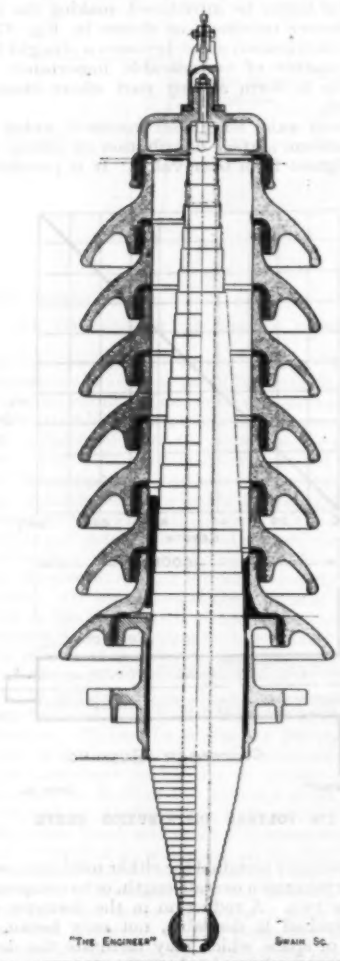


FIG. 182—OUTDOOR INSULATOR—METROPOLITAN VICKERS

Literature.

Pulverised Fuel, Colloidal Fuel, Fuel Economy and Smokeless Combustion. By LEONARD C. HARVEY. London: Macdonald and Evans. 1924. Price 42s. net.

THE author of this book is well known as an ardent believer in powdered fuel. His pamphlet on American practice is familiar, and has recently appeared in its third edition. The amount of material to his hand is so great, his knowledge of the subject is so extensive that, or so we imagine, his chief anxiety in the preparation of a book was to know what to leave out. He tells us that he has omitted many things, but nevertheless he has passed 460 quarto pages before he has done. We believe that to be the record for the subject. If anything, Mr. Harvey has been too conscientious. He might have omitted a good many more pages without robbing his book of its value. Indeed it would have gained by consciseness.

Mr. Harvey would perhaps be the first to admit that he is consumed with zeal for pulverised fuel. That zeal carries him away. If we may say so, he writes with a too ardent conviction of its astonishing merits. He never stops to give adequate consideration to any defects that it may possess—probably he is unaware that any exist—but briefly dismisses all adverse arguments and carries on his song of praise. The effect is that the volume smacks of propaganda. He appears to have set forth with the intention of convincing readers that pulverised fuel is "it." He has not the scientific detachment that is required in the author of a text-book. He is obviously a partisan. He is "out" to proselytise, to bring more believers into the fold. Powdered fuel has suffered a good deal at the hands of its prophets. It is not well to praise your friends too consistently and too warmly; it is better to let people find out some of the merits for themselves.

That is the chief fault of the book before us. Leaving it aside, there is much valuable information in the volume, and many useful figures and descriptions. It opens with an introduction in which the advantages of powdered fuel are set forth. In the second chapter Mr. Harvey outlines the reasons advanced against the use of pulverised fuel, and, of course, overthrows them. But he is always an advocate, not a judge, and he is more at home displaying the merits of powdered coal than in logically answering the objections to it. Probably he is quite unable to put himself in the position of those who are not as convinced of its merits as he is. Chapter III. might have been omitted. It was we imagine written a long time ago, when there was more necessity to enforce the need of economy of fuel resources than there is to-day. The cost of coal is doing what arguments could never have done. The succeeding chapter is designed to show that there is no solid fuel that is not the better for being powdered, and that there are several fuels that are inconsiderable for heat production until they are powdered. It is an interesting chapter, embellished with several valuable tables, and many notes drawn from a variety of sources. The next chapter, a long one, in the preparation of which Mr. H. S. Buckley has collaborated, is hardly necessary; at any rate, it might have been greatly shortened. It goes very carefully into combustion and efficiency calculation, but, except that here and there the special features of pulverised coal are considered, the material is of a familiar kind.

From that point onwards we find ourselves in the descriptive portion of the work. Here, for example, is a long chapter devoted to complete mill-house plants for the production of pulverised coal, in which a complete specification of a Fuller plant for an experimental locomotive fuel supply depôt is given. The cost of this elaborate plant is not given, but it is interesting to note that for an output of 150 tons per 20 working hours the gross weight—rather a curious figure to give—is 362,831 lb., or about 180 short tons. There used to be a fairly reliable figure of £40 per ton for all-round machinery. It would be nearer £80 now, so that in a rough and ready sort of way we may estimate the cost of the plant as £14,400, exclusive of the buildings. Probably there would be little or no change out of £20,000 before the plant was ready to start. Capitalising this sum at 5 per cent. gives us £1000 per annum! For depreciation and upkeep we must add another £3000 per annum, and we may guess working costs at not less than £2000 per annum. In all, say, on a very rough estimate, £6000 per year for 30,000 short tons of coal. If we put the value of the coal crushed at 20s. per ton—a high figure—6000 tons would have to be saved per year to pay for the plant. Now, 6000 tons is 20 per cent. of 30,000 tons, so that the economy effected by pulverising would have to amount to one-fifth. We admit that this is a very rough method of estimating, but it may help us to gain some idea of the economic position. We are not overlooking the fact that there are important countervailing advantages in some cases—notably the possible reduction in the size of boiler plant and all the attendant costs, the ability to use cheaper fuel and so on. It is obvious from the extension of the system in America that all these things when balanced up leave something to the credit side of pulverised fuel, and there is reason for believing that the system will be greatly extended in years to come, but more probably—in this country, at least—in connection with new power plants than by the replacement of existing mechanical stokers. We notice that in a later chapter Mr. Harvey gives an instructive table of costs, from which we see that he estimates the cost of a plant of the size we have been discussing at about £18,000, but he makes the total cost of preparing the coal 5s. 6d. per long ton, which brings the final figure something higher than our estimate. The table shows, however, that the total cost of preparation falls rapidly as the amount of coal increases. Thus from 5s. 6d. per ton with an output of 150 tons per day it drops to 4s. 1¼d. per ton with 1000 tons per day. We gather that the table has been compiled by the Fuller Engineering Company. The whole chapter, No. X., is one that will be closely scrutinised by all who are interested in the subject from the cash aspect.

We need not pursue a close examination of the remainder of the volume. It contains many descriptions and many tables and statistics, nearly all drawn from American sources. It is not always easy to say which are culled from independent and which from interested parties, and one is, therefore, a little in the dark as to their net value. But the most striking evidence of the success of powdered fuel burning is to be found in an appendix in which a long list—originally presented in *Chaleur et Industrie* in 1921—is reproduced. This list occupies no less than fourteen of Mr. Harvey's pages, and contains nothing but the briefest tabulated particulars about powdered fuel plants in all parts of the world and for all purposes—cement drying being omitted. It shows how extensive the use of the system already is.

We have suggested that Mr. Harvey's book smacks a little too much of propaganda, but that defect apart, it is a volume that will be generally welcomed, for a treatise on the subject of pulverised fuel was much needed. The literature is voluminous but very scattered, and it was time that it was collected between a pair of covers. We congratulate Mr. Leonard Harvey on the industry he has shown in the collection and presentation of it.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. II.* (SWITZERLAND).

(4) B. THE RHAETIAN RAILWAY.

THE Rhaetian Railway comprises a network of privately-owned, metre-gauge, single-track lines in the Grisons Canton (South-East Switzerland), totalling 277 route kilometres. The first part to be electrified included the Engadine lines, terminating at Schuls-Tarasp, St. Moritz and Pontresina, totalling 62 kiloms., and completed in 1913. The whole of the system is now electrified, the sections having been completed as follows :—

TABLE III.—*Electrification of the Rhaetian Railways.*

Section.	Length, kiloms.	Electrified in
Schuls–St. Moritz and Samaden–Pontresina	62	1913
Bevers–Filisur	31	1919
Davos–Filisur–Thusis	45	1919
Davos–Klosters	15	1920
Thusis–Landquart	41	1921
Landquart–Klosters	33	1921
Reichenau–Trins	5	1921
Trins–Dissentis	45	1922
Total	277	

For those sections electrified after the war, advantage was taken of the Federal law enacted in 1918 to provide loans for the electrification of private railways. The system adopted was single-phase at 11,000 volts, 16⅔ periods.

At Pontresina the single-phase Albula (Bevers–Filisur) line is connected to the Bernina Railway (direct current), which, in turn, links up with the Valtellina Railway (three-phase) in Italy. The electrification of the Engadine lines was proceeded with first because of the available power supply at Bevers sub-station, which receives three-phase energy *viâ* the Bernina Pass, from the Brusio hydro-electric station in the Poschiavo Valley, 40 kiloms. distant, at 23,000 volts, 50 periods. The converter part of the station is equipped with two converter groups, each comprising a three-phase motor of 900 horse-power, 450–540 revolutions per minute; a single-phase generator of 1300 kilovolt-ampère capacity at $\cos \varphi = 0.7$; and a direct-current motor-generator, which can take or supply a current of 2000 ampères at 500 volts. The ratings mentioned are continuous. These two sets have each a fly-wheel of 20 tons weight, with a moment of 150,000 kg.m².

The single-phase generators of these sets supply energy at 16⅔ periods and 2500 volts to a pair of transformers—1800 kilovolt-ampères each—in which the voltage is transformed up to 11,000 volts and is fed directly on to the contact line.

The direct current machines are connected to two accumulator batteries of 242 cells and of 1-hour capacity 1250 ampère-hours. This capacity can be raised to 1480 ampère-hours by the provision of extra plates. The voltage of each battery is 500 volts. When fully charged, the two batteries together can supply 1800 horse-power at the shafts of the single-phase generators through the medium of the coupled direct-current machines working as motors. In this way the fluctuations in the traction demand can be met, at the same time keeping the parallel-connected Thusis station fully loaded and the three-phase load on Brusio fairly equalised.

In 1919, as the electrification proceeded, arrangements were made to take a single-phase supply from the new private hydro-electric stations at Thusis and Küblis. These are high-head stations with small storage. The present service (1923) demands about 9 million units per annum, while that in 1913 would require 13 million units. The great fluctuations in load make it advisable for the railway company to purchase power in bulk from existing sources. All three stations are admirably situated for the Rhaetian Railway. Küblis station belongs to the Grisons Power Supply Company, while Thusis, Bevers and Brusio are the property of the Rhaetian Power Supply Company.

There are seven series of locomotives—see Supplement drawing*. The earliest engines are of the 1 B 1 type, Nos. 201–207. The drive is direct by connecting-rods from the single 300 horse-power Déri repulsion motor to a jack shaft. The 1 D 1 type, No. 301, has two motors similar to the above, but the drive is by means of a large triangular system of connecting-rods working on to one of the driving axles. The geared motors in the 1 D 1 locomotives—Nos. 351–352—are neutralised series machines, each but half the weight of the direct-drive motors in the previously mentioned locomotives, although of the same horse-power. The two motors engage with a single gear wheel on one side, the drive thence being by connecting-rod to a jack shaft. The 353–355 locomotives are similar to the 351–352 machines, except that since 1920 they have been equipped for regenerative braking. This extra apparatus weighs 2.5 tons, and enables the speed of an 80-ton train on a gradient of 45 per 1000 to be kept within 130 kiloms. per hour, and returns to the line about 30 per cent. of the energy required for the up journey. For generating, the traction motors are separately excited from the transformer, while choking coils are inserted in the armature circuit. The No. 391 locomotive is the same as the 351–352 type, except that the motors here are the A.E.G. series-repulsion type, and drive on helical toothed gear wheels on both sides. All the locomotives mentioned above are of pre-war construction. Of the locomotives supplied after the war, the 1 D 1 No. 302 machine, equipped with Déri motors with resistance connections between armature and commutator, drives by a triangular frame direct on the coupling-rod between two driving wheels. In the latest type—the C–C, Nos. 401–406 and 407–410—the neutralised series motors have, as elsewhere, ousted the repulsion motors; 1200 horse-power locomotives

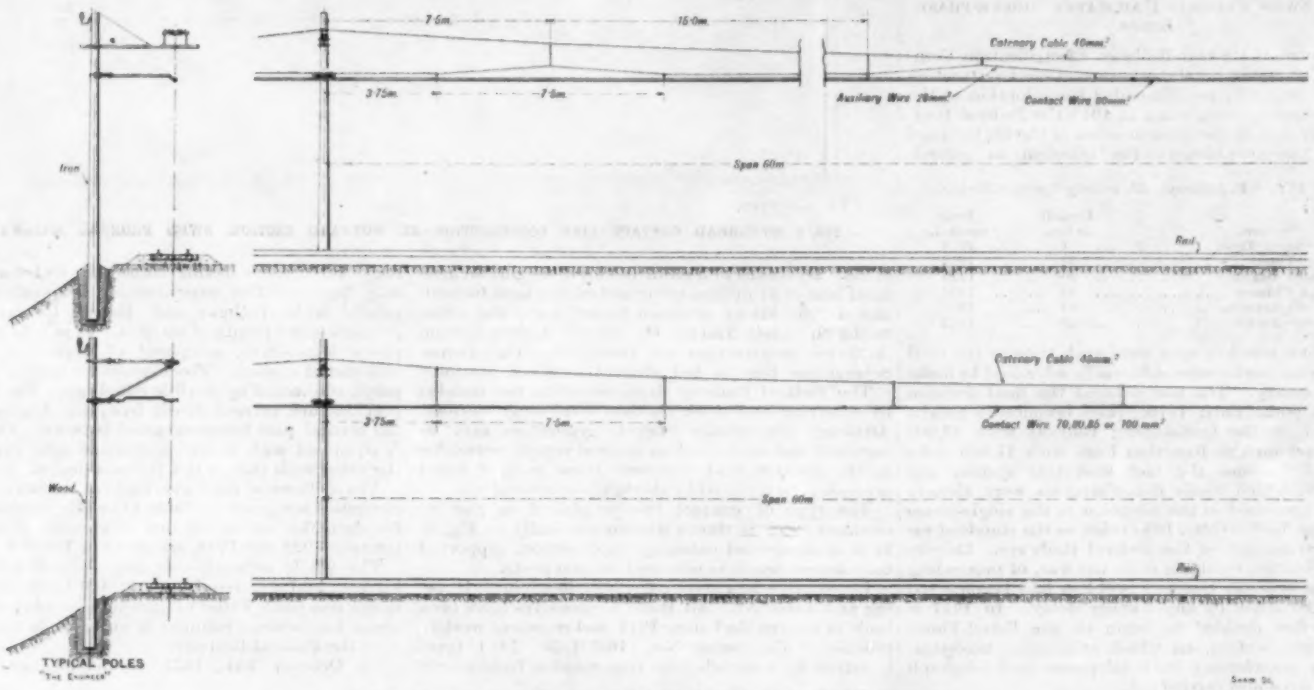


FIG. 4—OVERHEAD CONTACT-LINE CONSTRUCTION—RHAETIAN RAILWAY

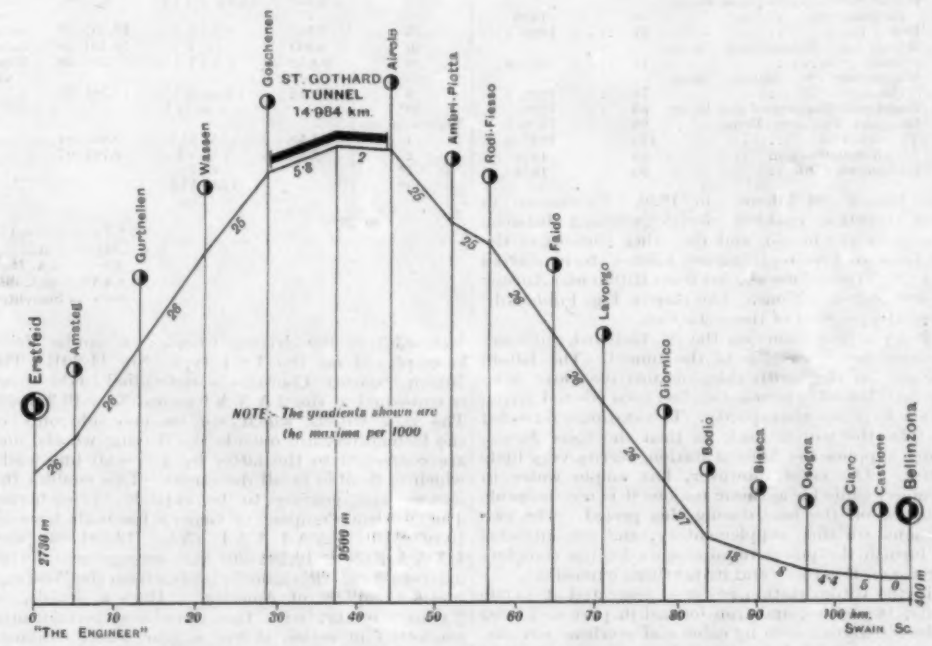


FIG. 5—PROFILE OF ST. GOTHARD TUNNEL SECTION—SWISS FEDERAL RAILWAYS

* No. I., with Supplements, appeared June 6th.

braking capable of dealing with half the train weight was adopted.

To eliminate interference, all inter-urban communication circuits have been removed to a distance of at least 20 m. from the track in order to comply with the Federal regulations, while the telegraph lines themselves have been provided with metallic returns. As regards the railway communication and signalling circuits, these have been removed to a minimum distance of 17 m., and the telegraph lines have been treated as above.

Fig. 4 shows the overhead line construction used on the Rhaetian Railway.

(4) C. Swiss Federal Railways: Single-phase Lines.

Although the Swiss Railway Electrification Commission's* report on the question of electric traction in 1912 definitely recommended the adoption of the single-phase system, when in 1913 the Federal Railways decided on the electrification of the St. Gothard route (Lucerne-Chiasso), the question as regards

Table IV.—*S.F. Railways, Electrically Operated Sections.*

Section.	Length in km.	Year opened.
Scherzligen–Thun	1	1918
Berne–Thun	31	1919
Erstfeld–Biasca	90	1920
Biasca–Chiasso	87	1922
Erstfeld–Lucerne	61	1922
Lucerne–Zürich	58	1923

the system was left open until such time as the civil engineering works were sufficiently advanced to make this necessary. The war delayed the final decision on this point until 1916. The favourable results obtained on the Loetschberg Railway with 15,000 volts, and on the Rhaetian lines with 11,000 volts single-phase, and the fact that this system was one with which Swiss manufacturers were already familiar, resulted in the adoption of the single-phase system at 15,000 volts, 16⅔ cycles, as the standard for the electrification of the Federal Railways. Despite the difficulties, resulting from the war, of proceeding with the scheme, the fuel problem had become too urgent to allow of any further delay. In 1917 it was further decided to begin on the Berne-Thun-Scherzligen section, on which exhaustive investigations on interference with telephone and telegraph circuits were also carried out.

Electric haulage began on the Berne-Scherzligen section in 1919, and through the St. Gothard Tunnel —15 kiloms. long, see Fig. 5—between Erstfeld

Table V.—*S.F.R. Electrification Work in Hand.*

Section.	Length, km.	Approx. year of opening.
Sitten (Sion)–Lausanne	92	1923–4
Lucerne–Basel	96	1924
Lausanne–Vallorbe and Yverdon	66	1924
Thalwil–Richterswil	15	1923
Zürich–Berne	130	1924–5
Lausanne–Geneva	61	1925
Zürich–Winterthur	27	1925
Zürich–Rapperswil	36	1925–6
Brigue–Sitten (three-phase to single-phase)	54	1926
Brugg–Basel	57	1926–7
Winterthur – Romanshorn – Rorschach	71	1927–8
Winterthur – St. Gallen – Rorschach	74	1926–7
Rothkreuz–Rapperswil and Brugg	53	1926–7
Lausanne–Palézieux–Berne	98	1926–7
Yverdon–Olten	125	1927–8
Zürich–Schaffhausen	48	1928
Richterswil–Chur	90	1928

and Biasca—90 kilomes.—in 1920. Extensions in each direction enabled electric working between Lucerne and Chiasso, and the other sections of the St. Gothard line, totalling 305 kilomes., to be started in 1922. These lines are fed from Ritom and Amsteg hydro-electric stations. The map in Fig. 1 *ante* indicates the position of these stations.

The power stations on the St. Gothard route are situated on either side of the tunnel. The Ritom station, on the south side, obtains its water from the lake Ritom, where a dam has been erected giving a very large storage capacity. This station is intended to take the winter load, as then the river Reuss, which supplies the Amsteg station, carries very little water. The river, however, has ample water in summer, while for æsthetic reasons it is not desirable to draw on the lake during this period. The two stations are thus supplementary, and are intended to furnish the power requirements for the complete service on this route and its northern extensions.

In the Ritom station power is generated at 15,000 volts, 16⅔ cycles, and transformed in part to 60,000 volts for transmission by cable and overhead circuits. In winter, the hot air from the generators is used to prevent freezing of the water at the penstocks and bends in the station. Water supply for the Amsteg station is obtained from the river Reuss between Wassen and Gurtnellen, and is conveyed through an 8 kilom. pressure tunnel to Amsteg.

In the west, work was begun in 1920 on the Rhone Valley section—Sitten-Lausanne. When the Sitten-Brigue section—see Sec. 4 D *post*—has been changed from three-phase to single-phase working, and the extensions Lausanne-Vallorbe and Lausanne-Yverdon are completed, the new Barberine power station in the Valais Alps will feed the whole Rhone Valley.

The Rhone Valley line power supply is derived from the Barberine hydro-electric station at Châtelard (Canton Valais). The station is a typical storage

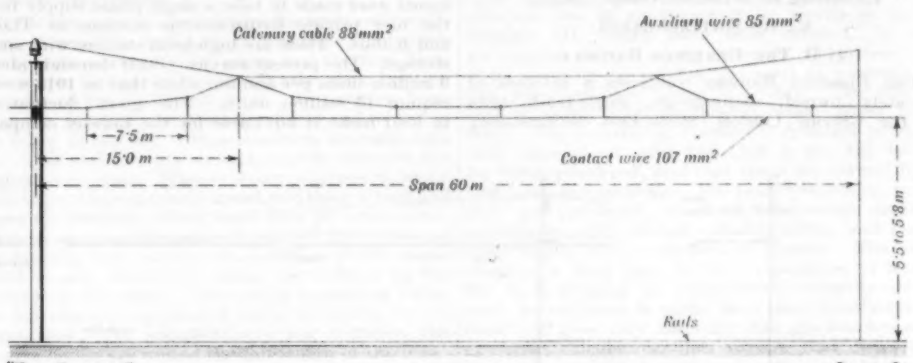


FIG. 6—OVERHEAD CONTACT-LINE CONSTRUCTION—ST. GOTHARD SECTION, SWISS FEDERAL RAILWAY

plant. By means of a dam, 100 m. in height, an artificial lake of 41 million cubic metres has been formed, and a 2.35 kilom. pressure tunnel leads the water to the pipe line. The head is 700 m. A lower station is under construction at Vernayaz. The Berne-Scherzligen line is fed from the Spiez station.†

The Federal Railway Administration has decided to construct and work its own generating stations. Although three-phase 50-cycle generators may be installed and connected to general supply networks, as the traction load increases these may, if found necessary, be replaced by single-phase generators.

The type of contact line employed on the St. Gothard route is shown diagrammatically in Fig. 6. It is of compound catenary construction, supported on yokes or brackets mounted on iron posts.

Locomotive data were given in our Supplement Drawing and Table XI. All these locomotives have been built in Switzerland since 1919, and represent modern practice. The series Nos. 10,401–20, 2 C 1 type, is driven by a Scotch yoke transmission from geared jack-axles to the driving wheels; a similar drive is employed for the 1 C 1 type, No. 11,201. The Brown, Boveri Company's individual-axle drive is embodied in the 2 A A A 1 series, Nos. 10,301–26. The gear wheels, which are on one side only of the locomotive, are outside the driving wheels, and are connected to the latter by a special link-work, which is flexible in all directions. This enables the motors and gearing to be entirely spring-borne. The Sécheron Company of Geneva has built locomotives with 1 A A 1–A A 1 (Nos. 12,501–06) and 1 A A A 1 (Nos. 10,201–20) axle arrangements, with individual-axle drive, under licence from the Westinghouse Company of America. Here a double, or "twin" motor, with two armatures permanently connected in series, drives a gear wheel mounted on a hollow quill surrounding the driving axle. Helical spring couplings are fitted between the gear wheel and the road wheel. The weight of the gearing is included in the electrical part. The 1 B–B 1 locomotives (Nos. 12,302–42) are fitted with electric brake arrangements, with rheostats and auxiliary transformer. Only the weight of the locomotive itself is electrically braked. The 1 C–C 1 locomotives (Nos. 14,251–83) are worthy of note for the unique system of connecting-rod drive. These machines are equipped for regenerative braking, which is effected by the use of a large choking coil. It is an extremely simple method and control is easy. The power factor during regeneration is very low.

The 15,000-volt motor coaches for local services may be mentioned. These are of the usual two-bogie type, some having three-axle and some two-axle bogies. The experimental locomotive, built jointly with Tschanz and Brown-Boveri drives, presents some points of interest. It is a 2520 horse-power locomotive, composed of a pair of 1 A A 1 articulated frames. The locomotive cab is in three parts, connected by flexible couplings. The two end portions are carried direct from the bogie frames, the central part being mounted between. One bogie is equipped with B.B.C. individual-axle drive, and the other with that of the Tschanz design.

The sections of the Swiss Federal Railways already electrified are given in Table IV. while those intended for electrification in the new accelerated programme between 1922 and 1928, are given in Table V.

The whole network—see Fig. 1—will total 1529 kilomes., and will require about 400 locomotives and motor coaches. Table VI. gives the number of single-phase locomotives running or on order in connection with the Federal Railways.

On October 30th, 1923, of 156 locomotives and 6 motor coaches, there were 115 locomotives and 4 motor coaches in commission.

Table VI.—*Numbers of Locomotives Running on, or under Construction for, the Federal Single-phase Lines on October 30th, 1923.*

Number of	Built by	Axle arrangement.	No.	Drive.	Remarks.
Locomotives.					
2	MFO	B–B	13,501–02	Side rods	Old Seebach–Wettingen locomotive
1	MFO	1 C 1	11,201	"	Experimental
2	MFO / BBC	1 B–B 1	12,301–02	"	Experimental
1	BBC	1 C–C 1	14 201	"	Experimental
1	SSW	C–C	14,101	"	Old Siemens locomotive
1	BBC	2 B 1	11,001	Tschanz and BBC	Old locomotive of French Midi Railway
33	MFO	1 C–C 1	14,251–83	Side rods	St. Gothard goods locomotives
40	BBC	1 B–B 1	12,303–42	"	St. Gothard express locomotives
2	BBC	1 C	16,301–02	"	Experimental shunting locomotives
1	BBC	1AA1 + 1AA1	11,000	Tschanz and BBC individual axle	Experimental drives
26	BBC	2 AAA 1	10,301–26	Individual axle	Express locomotives
20	MFO	2 C 1	10,401–20	Side rods	" "
20	SAAS	1 AAA 1	10,201–20	Westinghouse individual axle	" "
6	SAAS	1AA1–AA1	12,501–06	Ditto	St. Gothard express locomotives
50*	—	2C1 or 1C1	—	—	Express locomotives
Motor-coaches					
4	SAAS	A1A–A1A	9,801–04		Multiple-unit control
2	SAAS	AA–AA	9,701–02		Multiple-unit control and old motors of Midi Rly.
1*	—	B–2	—		250 H.P. Diesel-electric
10*	—	A1A–A1A	—		Electric motor coaches

* To be ordered before the end of 1923.

N.B.—MFO = Maschinenfabrik Oerlikon, Zürich.
BBC = S.A. Brown, Boveri et Cie., Baden.
SAAS = S.A. des Ateliers de Sécheron, Geneva.
SSW = Siemenschuckertwerke, Charlottenburg.

THE NEWCOMEN SOCIETY.

The Summer Meeting of the Newcomen Society will be held on Thursday and Friday, the 19th and 20th inst., with Shrewsbury as a centre. The following programme has been arranged. On Wednesday, June 18th, at 6 p.m. the London and district members will assemble at Paddington, and take the 6.10 p.m. train to Shrewsbury. On the Thursday, at 8.50 a.m., the party will assemble at Lion Hotel, and will start at 9 on a motor tour, visiting Hadley, for the inclined plane on the Shropshire Union Canal; Horsehay; Coalbrookdale, for blast-furnaces and water wheels; and Ironbridge, for bridge and water wheel. In the afternoon a return will be made to Shrewsbury, *viâ* Coalport, for the porcelain works; Coalport, for the inclined plane; Maddeley Court, Dawley, and Ketley. In the evening at 8.30 p.m. a paper on "Mineral Industries in the Coalbrookdale District," will be read by Mr. Rhys Jenkins, Member, at the Schools, Shrewsbury, at the invitation of the Headmaster, the Rev. Canon H. A. P. Sawyer. Afterwards the school library will be inspected.

On the Friday, the party will assemble at 8.50 a.m. at the Lion Hotel, and will start at 9 for a motor tour to Buildwas, for its bridge; Wroxeter, for the Roman city of Uriconium; Broseley, for tobacco pipe making; and Much Wenlock. In the afternoon a return will be made to Shrewsbury, and a tour made of the Castle and museum, under the leadership of Mr. H. E. Forrest.

* Commission suisse d'étude pour l'électrification des chemins de fer suisses.

† See Section 4 A.

Obituary.

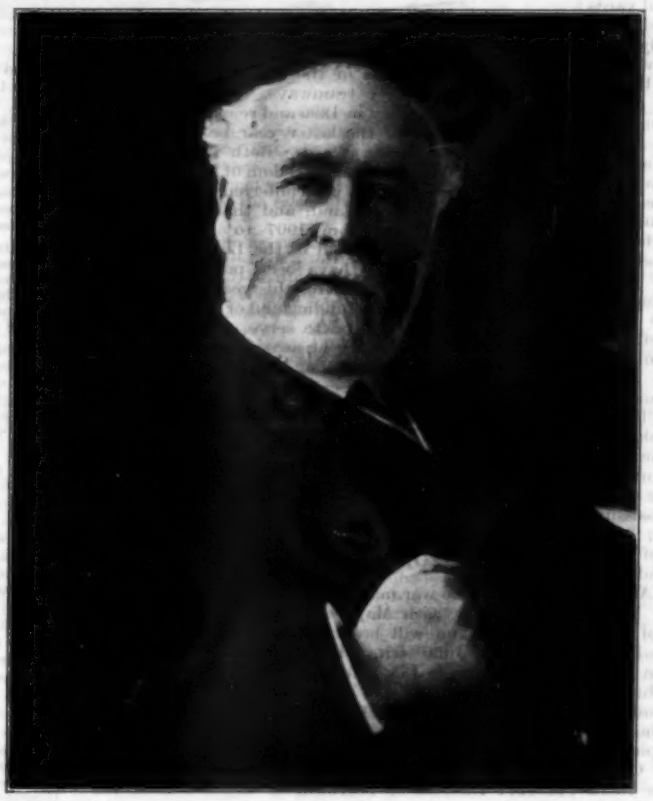
VISCOUNT PIRRIE.

IT is with sincere regret that we have to record the death of Viscount Pirrie, which occurred on Saturday last, while he was on a voyage from South America. Lord Pirrie left Southampton in March last to visit various South American ports on behalf of the Royal Mail Steam Packet Company—one of the very many businesses in which he was interested. He was actually on the way from Valparaiso to New York *viâ* the Panama Canal on the P. and O. liner Ebro when he caught a chill which brought on an attack of bronchial pneumonia. He died therefore as he would have wished to die, actually in harness, when returning from an arduous tour of inspection from which many not so old as he was might well have shrunk, and by his death not only is Belfast, his adopted city, for which he did so much, but the whole country and the Empire at large, very sensibly the poorer.

William James Pirrie was born in Quebec on May 31st, 1847. He had therefore just entered upon his seventy-eighth year at the time of his death. Though born in Canada, he was of pure Ulster blood. His father was the late Mr. James Alexander Pirrie, of Little Clandeboye, County Down, and his mother Eliza, the daughter of the late Mr. Alexander Montgomery, of Dundesart, County Antrim. He was an only son and his father died when he was only a year old. The mother, with her infant son, immediately returned to Ireland and settled at Conlig, a village in County Down, between Bangor and Newtownards. There the lad passed his childhood and received his early education. Later he was sent to the Royal Belfast Academical Institution, where he came under the influence of the late Dr. Blain and of the late Mr. John Carlisle, who was eventually to become his father-in-law. While at the Institution he is reported to have shown a marked aptitude for mathematics, but he was not destined to pursue his studies very far, for at the age of only fifteen he was apprenticed in the establishment of Harland and Wolff, of Queen's Island. That undertaking, which has since become so huge and widespreading, was then in its early infancy. Three years before, in 1859, Edward J. Harland, a native of Yorkshire, had acquired the shipyard of Robert Hickson and Co., whose manager he had been. In the next year he was joined in partnership by Mr. G. W. Wolff, a Jew of German birth. The firm was therefore but two years old when Pirrie entered it, and it was employing but 100 men or so. Nowadays, when times are normal, there are more than 20,000 hands on the pay roll, and for that vast increase in the numbers employed the young apprentice was to be very largely responsible.

The story of his early years with the firm reminds one forcibly of the lives of other engineers who have won their way to distinction. The story of Nasmyth and how he managed to pay for his lodging, food and clothing on ten shillings a week and devoted himself wholly to acquiring knowledge in Maudslay's workshops, comes readily to mind when we think of young Pirrie taking modest lodgings as near as possible to the works, being at his post the first in the morning and being the last to leave it at night. Of him as an apprentice it has been said that he was "diligent, painstaking, thorough, and earnest, and he seemed to make up his mind from the start that he would learn all that could be known concerning the building of ships. . . . No detail was too small or apparently too insignificant to escape his attention." Those may be the exuberant words of an enthusiastic and admiring biographer, but they exactly express Pirrie's attitude throughout his whole life. One of his most characteristic attributes was his capacity for taking trouble over details. That he worked hard and prospered exceedingly is, moreover, amply proved by the fact that when only twenty-two he had gained sufficient knowledge and experience to be made chief draughtsman, in which position he was responsible for the designs of some important steamships. In the intervening seven years he had passed through all departments of the works and become thoroughly conversant with all the shipbuilding and engineering operations carried out in them. Some of his love of shipping and his ability to grasp details in connection with it and with shipbuilding had doubtless been inherited by him from his grandfather, William Pirrie, who was not only a shipowner of high standing, but who was largely responsible for the straightening and deepening the channel through Belfast Lough from the sea to the city, which was opened in 1849, when the boy was just over two years only. The youth not only inherited his grandfather's traits, but followed in his footsteps in his love for the port and in his lifelong endeavours to do everything in his power to promote its interests.

Young Pirrie particularly attracted the attention and regard of the senior partner, Mr.—afterwards Sir—Edward Harland, and it was the influence of the latter which caused the young man to be taken into partnership in the year 1874, when he was only twenty-seven years of age. Thus he became one of the four eminent men, the others being Harland, Wolff, and Wilson, who directed so ably the fortunes of the great Belfast company, but none of whom now remain alive. It was a very considerable upward step for such a young man, with only twelve years' experience behind him, who had had, when he entered the works, hardly a penny piece to bless himself with, as the saying goes. That he had, even by that time, saved but little money is to be assumed, since he did not marry until some five years later, though long before he had met and fallen in love with the lady who was eventually to become his wife—Miss Margaret Montgomery Carlisle, daughter of the master at his old school, the Royal Belfast Academical Institution.



VISCOUNT PIRRIE

We may here, perhaps, be permitted to digress from our narrative for a moment to refer briefly to Lady Pirrie, who all their married life identified herself so intimately with her husband's activities. Lord Pirrie, not once, but many times, bore testimony to the help he had received and the inspiration he had derived from his wife, and that she had a very potent influence on his career there is no question. With all he did she associated herself, and on the many business journeys abroad which he had to make she accompanied him. She was with him on his last voyage when he was struck down, and she is about, so it is reported, to bring his remains home for interment in Belfast, the city which he loved so well.

Great as the firm of Harland and Wolff had become before Pirrie's admission to partnership, it rapidly grew in importance after his admission. It has been said of him that he was its "live wire." At any rate, business increased very considerably and new departures followed very closely after the entry of the "young blood." The conception of the giant ocean liner is by some attributed to Pirrie, rather than to any other member of the firm, and it is certainly true that the construction of the large steamers of the White Star Line, all of them built at Belfast, began in the early part of his association with it. In his position of chief draughtsman he must certainly have had an important share in the design of the original Oceanic, which was launched in 1870, and which had a gross tonnage of 3707. The Britannic and Germanic, both of just over 5000 tons gross, followed in 1874 and 1875. These two leviathans, as they were considered when they first appeared, and which reduced the crossing from this country to New York to under 7½ days, were undoubtedly of his design. And then followed at intervals the long line of White Star vessels of ever increasing dimensions. There were the fine sister vessels, Teutonic and Majestic, 528ft. long overall, with a displacement of 17,800 tons loaded, which were begun in 1889, and the huge Oceanic—the second of the name—which was launched ten years later, and which was no less than 705ft. 6in. overall and displaced, when loaded to a depth of 35ft. 7in., 31,590 tons. All these vessels were built under his eye, and so were the Olympic and the ill-fated Titanic, in the design of which he took special interest. It was, it may here be said, his custom to accompany on her maiden voyage any vessel embodying a new departure in size or other details, and had it not been for the fact that he had to undergo an operation and was laid up at the time, he would have sailed in the Titanic when she ran against the iceberg and sank with the loss of so many lives. Last of the line of the super giants of the White Star was the latest Britannic, 900ft. long with a tonnage of 50,000, which was launched in 1914 and which, while acting as a hospital ship, was torpedoed and sunk in the Ægean Sea during the war. The credit for the production of these increasingly huge and magnificently equipped and appointed floating palaces must very largely be attributed to Lord Pirrie, though the fine work of the staff of Harland and Wolff must by no means be lost sight of. But he it was who, practically entirely, assumed responsibility for their design and performance.

One point is well worthy of mention. Lord Pirrie insisted that everything should be done exactly as and when he wished it done. The building of ships was carried out to an exact schedule, which was—certainly on some occasions—actually drawn up before the keel plates were laid. We well remember on the occasion of the launch of the second Oceanic, in January, 1899, being shown by Mr. A. M. Carlisle, Mr.—as he then was—Pirrie's brother-in-law and able lieutenant, one such schedule having to do with that vessel. In it, though it was prepared, so we were told, before construction had been started, were laid down, not only the exact day, but the exact hour at which the vessel was to be sent into the water, and at the hour appointed she slid without hitch down the ways. That was typical of the man. He was method personified, and he had an almost uncanny instinct as to exactly how long things would take to do.

It was not, of course, only for the White Star Line that ships were built at Queen's Island. Many other steamship companies and railway companies, too, had their ships built there; but it would be impossible even to give a list of the companies themselves, much less of their boats. For the design of all these craft Lord Pirrie as head of the firm may be regarded as responsible, for very little went on in the works which he did not know about. It is, in fact, exceedingly difficult to draw a dividing line between the history of Harland and Wolff, Limited, and the life story of Lord Pirrie; but that which we have already said will serve to show the prominent part which he took in all the firm's enterprises. A word or two may, however, be usefully said as to what was done at Belfast during the war, when the yards were employed at full pressure day and night. First of all, there were boats disguised to look like battleships and armed with dummy guns. Fourteen were thus transformed and they served their purpose admirably. Then there were monitors, the first of which was built in only four and a-half months; some special river boats known as whippets; high-speed cruisers; and last, but not least, standard vessels, of which many were built, an astonishing record being set up in the case of one of them, which was actually completed in five days after being launched.

Lord Pirrie was nothing if not progressive. He not only moved with the times, but on many occasions was actually in front of them. It was he who introduced the interesting combination of reciprocating engines and geared turbines for ship propulsion. His foresight and insight were so keen that practically nothing which he touched turned out a failure. He seemed to know intuitively what would succeed and what would fail. He was, from the very first, a believer in the internal combustion engine for marine work, which, considering that he had, from his earliest years, been accustomed to see steam and steam alone used for the purpose, might appear strange to anyone not

acquainted with his character; but his one aim was to produce ships which should be the very best for the purposes for which they were intended, and in reaching his objective he did not allow preconceived ideas to influence him. As a result of the continual enlargement of his views Queen's Island eventually became too small. Expansion had to take place, and expansion there was. He turned naturally to the Clyde and Liverpool at first. Then followed Southampton and, finally, the Thames. On the Cyde he obtained a controlling influence in the undertaking belonging to John Brown and Co., Limited. Then the yard at Govan and the engineering works and boiler shops at Lancefield-street, belonging to the London and Glasgow Engineering and Iron Shipbuilding Company, were acquired, as were also, in turn, the establishments of Mackie and Thompson, Limited, of D. and W. Henderson, Limited, at Meadowside, of Caird and Co., of Greenock, Robert Napier and Sons, and an interest in the firm of A. MacMillan and Son, Limited. He also established works at Stobcross Quay for the manufacture of marine Diesel engines of the Burmeister and Wain type. Incidentally, it may be remarked that, since the war, he acquired the factory at Scotstoun originally started by the Coventry Ordnance Works, Limited, and there, too, Diesel engines are being made. At Liverpool the firm has a large and well-equipped repairing and engineering works, which did most excellent service during the war. At Southampton and London there are similar establishments. Comparatively recently, too, Lord Pirrie founded an additional shipyard in the Musgrave Channel at Belfast. In fact, with its works and yards in this country and those abroad with which it is closely allied, Harland and Wolff Ltd. may justly claim to be the biggest and most important shipbuilding and repairing undertaking in the world, and it became so very largely, if not entirely, through the energy and go-aheadness—if such a term be permitted—of Lord Pirrie.

It is perhaps astonishing, considering the calls made upon his time by the work connected with his firm, that he found leisure to do anything else; but, as a matter of fact, he was a man with a host of other interests. The number of businesses with which he was connected, either as a director or in some other way, was very large, nor were they by any means confined to Belfast or to Ireland. He was chairman of the African Steamship Company, of the Ocean Transport Company, Limited, and of the Glen Line, Limited. He was a director of the Ocean Steam Navigation Company, Limited (the White Star Line); of the London and South-Western Railway Company; of the London City and Midland Executor and Trustee Company, Limited; of the Eastern Telegraph Company, Limited; of the International Marine Company, of New Jersey; of Fred Leyland and Co., Limited; of the British and North Atlantic Steam Navigation Company, Limited; of the Mississippi and Dominion Steamship Company, Limited; of the Wilson and Furness-Leyland Line, Limited; of Elder, Dempster and Co., Limited; of Lamport and Holt, Limited; of A. and J. Inglis, Limited; of the Alliance Debenture Corporation, Limited; of the British and Mexican Petroleum Company, Limited, of which he was also chairman; of the Burmeister and Wain Oil Engine Company, Limited; of the Union Castle Mail Steamship Company; of the Watertight Door Company; and of the Scottish Widows' Fund Life Assurance Society. He was a member of the Committee of Lloyd's Register of British Shipping; a member of the Board of Trade Conciliation Court's panel; a member of the Advisory Committee to the Board on new lighthouse work; a past member of the Council of the Institution of Mechanical Engineers; and a member of the Institution of Civil Engineers and of the Worshipful Company of Shipwrights; a vice-president of the Institution of Naval Architects; and an honorary member of the Institute of Journalists. Some years ago he joined with Lord Iveagh in the promotion of a scheme for developing backward portions of Ireland by the introduction of better transport facilities, and he was a member of the Viceregal Commission on Irish Railways. He was a past president of the Chamber of Shipping of the United Kingdom, and for some years he was a director of the old Belfast and Northern Counties Railway, afterwards taken over by the Midland Railway of England. We must not omit to mention the excellent work he did during the war as Controller-General of Merchant Shipping, when he did so much to expedite in his own and other yards the construction of much-needed shipping.

In 1897 he was sworn in as a member of the Irish Privy Council, and in 1906 was elevated to the peerage as Baron Pirrie. Subsequently he was appointed a Knight of St. Patrick. On the occasion of the visit of their Majesties the King and Queen to open the Northern Parliament in 1921 he was made Viscount. He was one of the original members of the Senate.

Lord Pirrie, as has been intimated, also managed to find time to make himself exceedingly useful to Belfast and its institutions. In 1893 he was elected a member of the Belfast Harbour Trust, a position which he maintained for thirteen years. In the same year he entered the Corporation of Belfast as an Alderman for the Cromac Ward, a post which he filled for nine years, holding, amongst other offices, that of Chairman of the Electricity Committee, on which he was a strong advocate of the acquisition and electrification of the city tramways. He was elected Lord Mayor of the city in 1896 and re-elected in 1897. In the November of the latter year he was elected Alderman for Victoria Ward. Both he and Lady Pirrie received the honorary freedom of the city. The honorary degree of LL.D. was conferred on him by the Royal University of Ireland, and that of D.Sc. by Dublin University. From 1907 to 1913 he was Controller of the Household of the Lord Lieutenant of Ireland. He would have been president of the Belfast Chamber of Commerce this year, but because of the depression in shipbuilding and of the unemployment problem he declined to serve, though he consented to his name remaining as senior vice-president with a view to his occupying the chair during the year 1925–6. He represented for many years the Chamber of Commerce Committee on the Irish Lights Advisory Committee. He was Lord Lieutenant of the city of Belfast from 1911, a Justice of the Peace for Belfast and for the counties of Antrim and Down, as well as being High Sheriff of County Antrim in 1898 and of County Down in 1899.

SIR GEORGE SCOTT-MONCRIEFF.

DURING the war many civil engineers were brought into contact with Major-General Sir George Scott-Moncrieff, and will hear with regret of his sudden death on June 4th, whilst travelling in Poland. He was born in 1855, and was gazetted to the Royal Engineers in 1873. In '78 he was appointed assistant engineer in the P.W.D. He lived in India for about ten years, and after spending some years in England, returned there again and remained until 1904. In 1909 he became Chief Engineer at Aldershot, and in 1911 Director of Fortification and Works at the War Office. It was in this position, and particularly in connection with his plans for housing the vast armies that had to be raised during the war, that Sir George Scott-Moncrieff became known to many civil engineers and contractors. One of his last duties at the War Office was the selection of an engineer to supervise the rebuilding of Halifax, Nova Scotia, which had been almost wiped out by the explosion of December, 1917. On leaving the War Office he joined the firm of Macdonald, Gibbs and Co., and whilst with them was engaged on the development of the shale oil fields near King's Lynn, but in 1921 was obliged, owing to indifferent health, to retire from active life.

DR. R. H. JUDE.

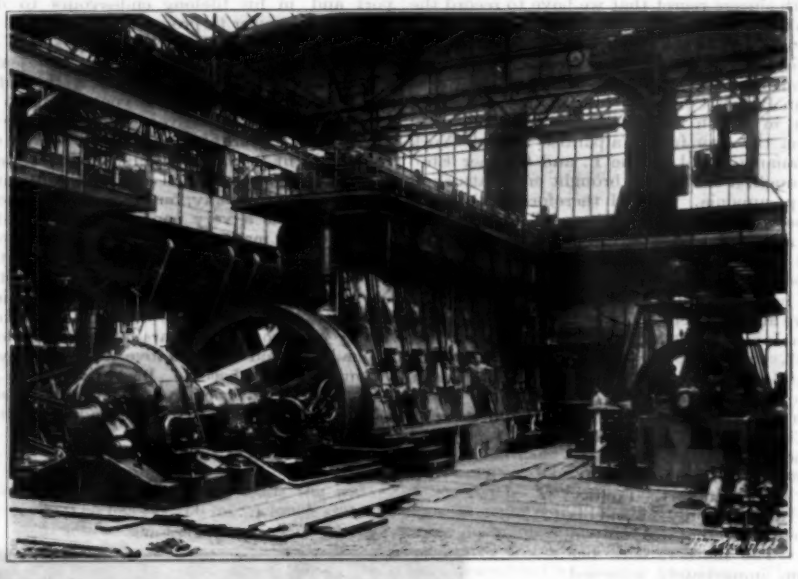
THE death occurred at Eltham, on the 1st inst., of Dr. R. H. Jude, who was for thirty years head of the Physical and Mathematical Departments of Rutherford College, Newcastle-on-Tyne. Dr. Jude was the author of many books dealing with electricity and magnetism. He originated and taught special classes in higher mathematics for engineers, and he contributed to the Popular Saturday Night Science Lectures at Newcastle. He was seventy-one years of age.

A Large Diesel Engine for China.

THE following notes on the trials of a 3600 brake horse power two-cycle stationary Diesel engine, which were held during the month of February at the Winterthur works of Sulzer Brothers, may prove of interest to our readers. A brief account is given of the time taken to build and test the engine and of the results obtained. We show on the accompanying illustration a view of the test bed and the 3600 horse-power engine coupled to the water brake, while alongside it to the right is a smaller engine of 375 brake horse-power in course of erection. This large unit was ordered by the Compagnie Française de Tramways et D'Eclairage Electrique de Shanghai, and is of practically the same size as the engine supplied by the builders to Harland and Wolff at Belfast in 1915. The following are its leading dimensions:—

3600 B.H.P. DIESEL ENGINE FOR SHANGHAI

SULZER BROTHERS, WINTERTHUR, ENGINEERS.



Number of cylinders	6
Diameter of cylinders	760 mm. (29¾in.)
Stroke	1020 mm. (40¼in.)
Full load power	3600 B.H.P.
Normal speed	125 revs. per min.
Total weight	400 tons

The engine was built and erected in the comparatively short time of eight months, and after dismantling in the erecting shop, its re-erection on the test bed reserved for large engines was begun on February 2nd last. Exactly two weeks later, on February 15th, the engine was run without load for the first time. Three days later the hydraulic brake was coupled up, and on the 21st inst. a trial was carried out. Four days were spent in making final adjustments and in preparing the engine for the guarantee trials. Only twenty-one working days therefore were required to erect the engine on the test bed, to carry out the final adjustments, and to run the preliminary trials.

The guarantee trials took place on February 28th and the following day in the presence of the engineers of the Shanghai company. On the first day the engine was run continuously for 10 hours on the following loads:—Full load, 7½ hours; 10 per cent. overload, 2 hours; 20 per cent. overload, ½ hour. The trials with the engine partly loaded were carried out the day following the full-load overload trials, and the following results have been supplied to us by the engine builders:—

Load.	Full.	¾.	½.
Fuel consumption, in lb. per B.H.P. hour	0.415	0.422	0.458
Grammes per B.H.P. hour	188.5	191.2	208.0
Guaranteed fuel consumption in grammes	190.0	195.0	215.0

The guarantee figures given were subject to a 5 per cent. tolerance, but it will be noted that the actual amount of fuel consumed by the engine at all loads was well below the figures guaranteed without claiming any tolerance. Gas oil, having a calorific value of 18,000 B.Th.U. per lb., or 10,000 calories per kilogramme, was used for the trials. The consumption of lubricating oil for the cylinders was, we are informed, only 0.8 grammes per brake horse-power hour, and that incurred in the lubrication of the main bearings, vertical shaft, &c., by a forced system is so small that it can only be accurately determined after a prolonged period of service. Other outstanding features of the trial were, we learn, the smooth running and absence of vibration, the accurate governing and the uniformly clear exhaust. The engine is to be installed at Shanghai in the same power station in which two 1500 brake horse-power two-cycle engines by the same builders are already in service. Like the previous units, the new unit will be employed in driving a three-phase alternator of the fly-wheel type.

COLONEL CROMPTON'S EIGHTIETH BIRTHDAY.—A very happy little ceremony took place at the Royal Automobile Club on Monday, June 2nd, when the Institution of Automobile Engineers gave a dinner to celebrate the eightieth birthday of Colonel R. E. Crompton, the first president of the Institution. A very representative gathering was present to do honour to the guest of the evening, and his praises were well sung by Mr. H. G. Burford, the present president. Mr. Burford, before sitting down, presented to Colonel Crompton a scroll enrolling him as one of the four honorary life members of the Institution. Sir Arthur Stanley, in the course of a speech in his happiest vein, as seconding the toast, duplicated the honour by making Colonel Crompton an honorary life member of the Royal Automobile Club. At the conclusion of the dinner Colonel Crompton gave a very interesting lecture on "A Forgotten Chapter in the History of Road Locomotion," illustrated by lantern slides, in the course of which he rendered due honour to the memory of Mr. R. W. Thomson for the great part he had taken in the introduction of the rubber tire in days long before it was generally used on automobile vehicles.

Railway Matters.

AT the adjourned inquest on Friday last on the five passengers killed in the collision at Euston on April 26th, a verdict of "accidental death" was returned.

THE only entry of special interest to railwaymen in particular in the Birthday Honours is a knighthood for Mr. R. L. Wedgwood, the general manager of the London and North-Eastern Railway.

THE run from King's Cross to Bradford by the Pullman connection takes 3 h. 53 min. This time, though only three minutes faster than the best ordinary train from King's Cross, is over an hour faster than that usually given from St. Pancras.

A CONFIDENTIAL report on the market for locomotives in Poland has been prepared by the Department of Overseas Trade from information received from the Commercial Secretary at Warsaw, Mr. R. E. Kimens, C.M.G., and issued to firms whose names are entered on its special register. United Kingdom firms desirous of receiving a copy of this report should communicate with the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

ON the second reading, in the House of Lords, of the London and North-Eastern Railway Bill, Viscount Gray of Fallodon, a director of the company, explained why railway companies wished to have powers to build on land they owned. At present they were compelled, under the Land Clauses Consolidation Act, 1845, to sell all superfluous land, but met this obligation by clauses in their Bills to allow them to retain such land. They had power to sell land for other people to build on, but could not themselves build except for railway purposes.

IN view of a reorganisation of the administration of the London and North-Eastern Railway, Mr. S. A. Parnwell is relinquishing the position of divisional general manager of the Southern area and is being succeeded by Mr. Alexander Wilson, the divisional general manager of the North-Eastern area. Mr. George Davidson, who was the general manager of the Great North of Scotland until its amalgamation and has since been the solicitor for Scotland, goes to York to succeed Mr. Wilson, and will have as his assistant Mr. Paul Gibb, now assistant to Mr. Parnwell.

THE transport of a 50-ton electric turbine made at Birmingham for the Sydney Corporation necessitated steel sheets being laid over the road from the works to the L.M.S. goods station at Witton in order to prevent the huge load from sinking through the surface and damaging the gas and water mains. Ten hours were taken to complete the journey of a little over a mile. At the station the turbine was lifted from the lorry by two powerful cranes, which had to be specially sent from the London, Midland and Scottish works at Crewe. A railway truck of special design carried the turbine to Manchester, whence it was shipped by a Clan liner to Sydney.

THOSE who are hoping for the early electrification of the Great Northern area, if not the Great Eastern also, will find some comfort in the fact that the London and North-Eastern Railway has appointed an electrical engineer in the person of Mr. H. W. H. Richards. It is officially announced that "Mr. Richards will be responsible to the chief mechanical engineer (Mr. Gresley) for all electrical engineering work in connection with traction, power and lighting in the Southern area, and will act in an advisory capacity to him in connection with such work for the rest of the system." This appointment is of unusual interest, in that Mr. Richards has been practically in charge of the electrification of the Brighton section of the Southern Railway.

SOME interesting changes are being made in the mechanical engineering department of the London and North-Eastern Railway. Mr. Chalmers, who was the locomotive superintendent of the North British Railway and became the mechanical engineer for the Southern Scottish area, retires at the end of this month. Mr. R. A. Thom, who was the assistant to Mr. J. G. Robinson and became the district mechanical engineer at Gorton, goes to Cowlairs to succeed Mr. Chalmers, and is to be succeeded by Mr. T. E. Heywood from Inveruric, whose position will not be filled, as Mr. Thom is to act as mechanical engineer "for Scotland," *i.e.*, for both the North British and Great North of Scotland areas. As Mr. K. S. Robertson, the works manager at Inveruric, is also moving, it looks as though the works there are about to be more or less closed down. Mr. J. H. B. Jenkins, of the Great Eastern section, becomes chief chemist to the London and North-Eastern Railway, and Mr. H. Gripper, of the Great Central, the deputy chief chemist.

THE month of June has seen two noteworthy railway accidents, including the worst, except Quintinshill, on record. It was the Armagh disaster of June 12th, 1889, when an excursion train became stalled on a rising gradient. The train was divided and, the rear portion, not being properly secured, ran back and met another passenger train. Eighty passengers, mostly children, were killed. Two safety appliances, which the Board of Trade had been long demanding, were absent—the automatic feature of continuous brakes and the block system—and this disaster led to a Bill quickly being passed to make these and the concentration and interlocking of points and signals compulsory on passenger lines. The Government of the day sought to secure automatic couplings also, but fortunately withdrew the clauses. The other noteworthy accident was that which occurred at Slough on June 16th, 1900, when a driver, in broad daylight, ran past the distant and stop signals at two boxes and caused a collision in which five passengers were killed. Sir Arthur Yorke's report was noteworthy in that it pointed out that what is now called automatic train control substituted the assumed reliability of a machine for the uncertainty of the human agent. The human agent would not, however, be dispensed with, as the efficiency of such an appliance would depend on the care and intelligence bestowed upon the maintenance of its separate parts. Sir Arthur also considered that "drivers, having been taught to rely upon the apparatus, would pay less heed to signals than at present."

Notes and Memoranda.

ACCORDING to Mr. Sam Mavor, nearly 90 per cent. of the coal raised in England is still got by hand, and is man-handled in trams.

A BORE-HOLE put down at Santa Fé Springs, California, by the Standard Oil Company in a futile effort to find oil, is said to break several records. It was drilled to a depth of 7212ft. by rotary tools in 323 days, and none of the drilling equipment was lost. The drill pipe and tools weighed some 55 tons. A considerable flow of water at a temperature of 180 deg. Fah. was encountered.

THE National Automobile Chamber of Commerce, in its statistical survey of the United States motor industry for 1923, states that the production reached a total of 4,086,997 vehicles, of which 3,694,237 were cars. This represents an advance of 22.5 per cent. on the output for 1922. Of this total, only 328,999 vehicles were exported. The industry absorbed 3¼ million tons of iron and steel.

THE Industrial Fatigue Research Board has issued through the Stationery Office its fourth annual report, to December 31st last, including personal contributions from investigators. In concluding the account of the work carried out during the past year, the Board makes some general observations on the work hitherto carried out and on the lines on which this work may most appropriately be extended in the future.

THE Luena coalfield, in Belgian Congo, is estimated to contain 12,000,000 tons, but of these only 7,000,000 tons are workable. The Luena Coal Company has searched for coal in other parts of Katanga, and has discovered a deposit of about 1,000,000 tons in the Lukuga district. The works of the Union Minière du Haut Katanga have, since the beginning, drawn their full supplies from the Wankie Colliery in Rhodesia. The quantity thus supplied during the last quarter of 1923 was 43,760 tons of coal and coke.

IN the electric brass melting field, the United States is said to have attained a tremendous lead over all foreign countries. Whereas in the United States there are about 540 active electric furnaces doing commercial non-ferrous melting, it is doubtful whether all other countries combined use 100 electric brass furnaces. Of the American furnaces, about 275 are induction furnaces, about 135 are moving indirect arc furnaces, 80 are Baily furnaces, while the remaining 50 furnaces are of various types.

FROM the mining supplement of *Canada* we learn that on the northern coast of British Columbia there are numerous small, floating wharves at places where there are not even settlements. They are used as a convenience in getting supplies to interior points. A diamond drill crew was put off at one of them and after the steamer had gone it was found they were in the wrong place. It was here that the mechanical genius of one of the men was shown. He put a twist in a piece of sheet metal, fired up the boiler, attached to the drill the twisted metal as a propeller and set sail, float and all, for the true destination.

THE United States Department of Commerce has made another step towards the simplification of manufacture in recommending the elimination of 165 odd sizes and types of files and rasps now on the market. The makers have agreed to adopt the policy for at least one year. A standing committee representing manufacturers, distributors and users has also been appointed to ensure the adoption of the simplification embodied in the recommendation, to effect a greater degree of contact and co-operation between the Department of Commerce and the various manufacturers and organisations connected with the industry, and to consider periodic re-surveys for constructive revision or substitutions.

COMMENTING on the growing use of crêpe rubber as an abrasion resisting material, the *Chemical Trade Journal* says that the popularity of unvulcanised rubber is remarkable when it is considered that the vulcanisation process was elaborated with the object of improving the mechanical properties of raw material and its resistance to temperature changes. It must not be overlooked, however, that the pale crêpe rubber, which is the principal product of the modern plantation, is in many respects a different material from the crude Para rubber with which the pioneers of the industry had to work, and its increasing application in the unvulcanised condition indicates, not so much a reversion to rather unsatisfactory earlier practice, as the exploitation of what is really a new raw material.

THE geographical features of the Winnipeg River lend themselves admirably to the development of hydro-electric enterprises, and this fact enables the citizens of Winnipeg to obtain electrical energy at rates believed to be the lowest in the world. Power is supplied to large consumers at rates ranging from 1/5 cent. per kilowatt-hour, for domestic heating at 9/10 cent. per kilowatt-hour, and for domestic lighting at 3 cents per kilowatt-hour. The greatest load yet carried by the system is 42,000 kilovolt-ampères, and this load has, for some years, been increasing at the rate of about 14 per cent. per annum. The daily load factor is about 70 per cent., and the seasonal load factor is about 45 per cent., and the latter would be higher were it not for the large heating load which is supplied only in the winter.

THAT the hydraulic resources of Italy are being actively developed is shown by the figures for central stations now under construction, which will be finished by 1925. Of these, there are twenty-four which will generate 2,209,000,000 kilowatt-hours, while plans are being made for fifty-six to generate 3,908,500,000 kilowatt-hours per year. It is interesting to note that of those under construction, an important number are in Southern Italy (Calabria and Sardinia), where the lack of cheap power for industrial purposes has hitherto unduly retarded development. Very important plants are also being built and planned in the Trentino. In connection with these central stations, six artificial lakes are now being built, which will be completed by 1927, with a content of 340,475,000 cubic metres of water. Plans are being prepared for fifteen others, with a content of 682,000,000 cubic metres of water.

Miscellanea.

THE Norwegian Industrial Fair will be held at Christiania from August 31st to September 30th.

THE Industrial Court has decided that the allowances to piece-working members of the Boilermakers' Society for overtime shall be 33⅓ per cent.

A PLANT for the manufacture of high-speed steel is being put down by the Sociedad Anonima Echevarria, of Bilbao. The company is building a second blast-furnace and extending its rolling mills.

THE Darlington Town Council proposes to replace the worn-out tramway system by trolley omnibuses, at a cost of £60,000. It is estimated that the reconstruction of the tramway track would cost £200,000.

WE are asked by the Institute of Patentees to say that the Institute will hold an exhibition of inventions from August 11th to 16th, 1924, in Aldwych House, Kingsway, W.C. 2. Monetary prizes will be awarded for the best inventions.

IN connection with developments projected by the Seaton Delaval Coal Company, Limited, sinkers have reached the Beaumont seam at the Hastings Pit, New Hartley, which is the lowest seam yet touched by the company. The new seam is 2ft. 6in. thick and of excellent quality.

SINKERS at the Markham Main Colliery, the workings of which will be under the town of Doncaster and the race-course, have reached the Barnsley seam of coal in No. 2 shaft at a depth of 731 yards. Three weeks ago the Barnsley seam was reached in No. 1 shaft at a depth of 730 yards. When the pit is in full working order, employment will be found for between 3000 and 4000 men.

AN International Exhibition is to be held in Dunedin, New Zealand, opening about November 12th, 1925. The New Zealand Government has given its patronage to the project, and is also assisting it financially. This will be the fourth International Exhibition held in New Zealand. The last, held in Christchurch in 1906–7, was a great success, and it is hoped that next year's event will surpass all previous records.

THE annual accounts of the Coventry Corporation electricity undertaking for the year ended March 31st last show a net profit of £47,800, as compared with a profit of £46,038 in the previous twelve months. The annual accounts of the sewage disposal undertaking for the same period show a small profit on the agricultural working of the sewage farm, and that the total cost of dealing with the sewage of the city was £19,518, as compared with £22,652 in 1922–23.

THE South African Railways and Harbours Administration has decided to assume control and jurisdiction of the Saldanha Bay harbour, and to construct a jetty at Hoetjies Bay, 100ft. or so in length, for the handling of goods and passenger traffic. It has been suggested that this jetty should be constructed on the lines of a promenade pier. It is also proposed to convert the existing narrow-gauge railway from Kalabas Kraal to Saldanha to the standard gauge, thus materially accelerating travelling facilities.

Two more coal mines have been opened up in Manchuria in the Fengtien district, west of the Liao River. One of these mines, in the foothills west of Koupangtzu Junction on the Pekin–Mukden Railway, has been in operation over a year. Recently the Bureau of Mines despatched a trained mining engineer and staff to bore for coal at or near a mine 13 miles west of Takumen. Preliminary surveys have demonstrated that there is a wide field in the neighbourhood. If the yield turns out as satisfactory as is expected, this mine will, like the first, be connected with the Pekin–Mukden Railway. To the nearest station, Hsinmintun, a line of some 53 miles would be required.

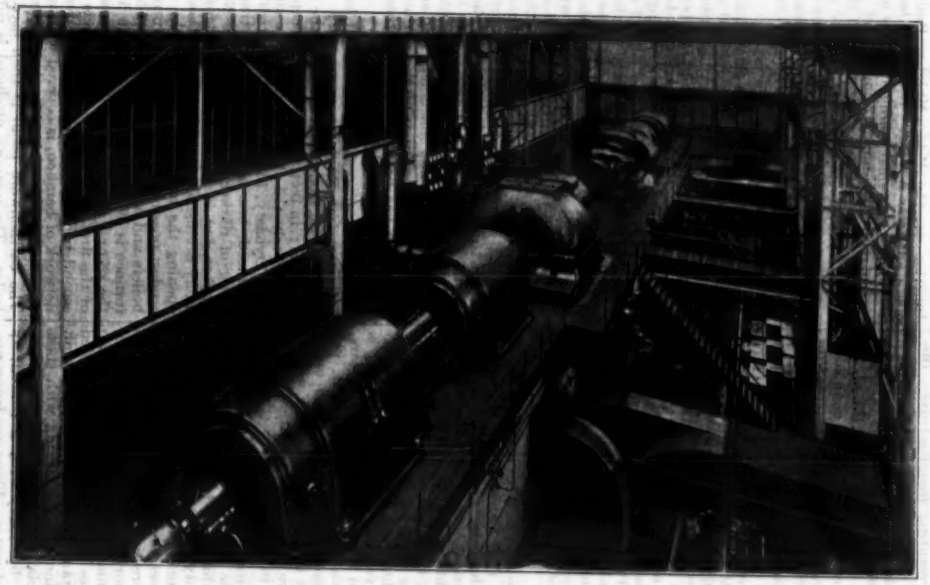
THE annual report of the Shanghai Municipal Council electric department has just reached us. Notwithstanding the continued trade depression, the sales of electricity in 1923 for various purposes increased from 232,457,361 to 272,265,861 kilowatt-hours, or 17.12 per cent. The result of the year's trading shows a net profit of Tls. 1,514,884. Whilst the sales of electricity for light, heat, and traction came closely to the estimated figures, the sales for power purposes were short by 18,278,115. In the report for 1922 reference was made to the inactivity of most of the flour mills supplied with electric power. During 1923 this industry was more active, and most of the mills were working at intervals. Against this recovery has to be set the falling off of demand in the cotton-spinning industry. Although few of the mills actually ceased to run, some of them went on half time; consequently, the sales of electricity were lessened proportionately. Mills in which new spinning plant had been added did not put this new machinery into service. Considering the depressed condition of the cotton industry, the fact that there has been an actual increase in sales of power may be regarded with satisfaction.

FOR many generations, states the *Chemical Trade Journal and Chemical Engineer*, a mercury mine has been in operation at Dong-shun-hsien, in the Kweichow province of China; in fact, it is generally accepted that mining has been conducted there continuously since the days of the Ming Dynasty, 1368–1644. Of the two varieties of mercury produced, one is bright red and transparent, the other being of darker red, but opaque. Neither contains any pyrites, but in the latter variety small amounts of antimony are usually found. The methods adopted, both for opening the mine and smelting the mineral, are of the crudest possible description. The furnaces consist of three boilers and an earthenware basin. The foundation of the furnace is of brick, and on this the first boiler is placed; the second boiler is then placed upside down on the top of the first, and a 12in. hole is made in the centre. The second boiler, which is kept in the required position by a network of bamboo, is covered with mud, and on this the third boiler, also with a 12in. hole in the centre, is mounted. The earthenware basin is then used to cover the third boiler. The mercury produced is rubbed off the basin—where it condenses—and transferred to tubes made of bamboo, in which crude containers it is marketed,

THE NORTH TEES POWER STATION

MESSRS. MERZ AND McLELLAN, LONDON, ENGINEERS

(*For description see page 664*)



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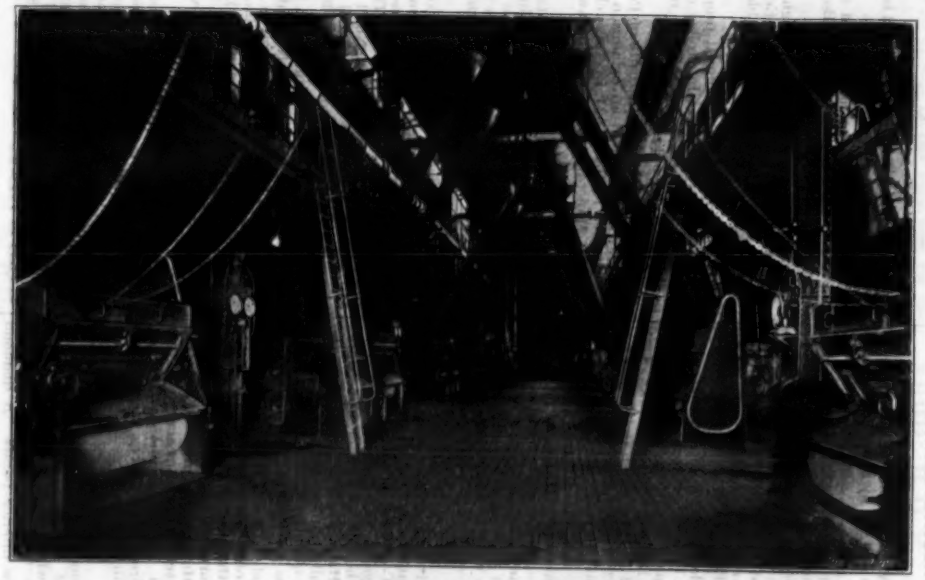

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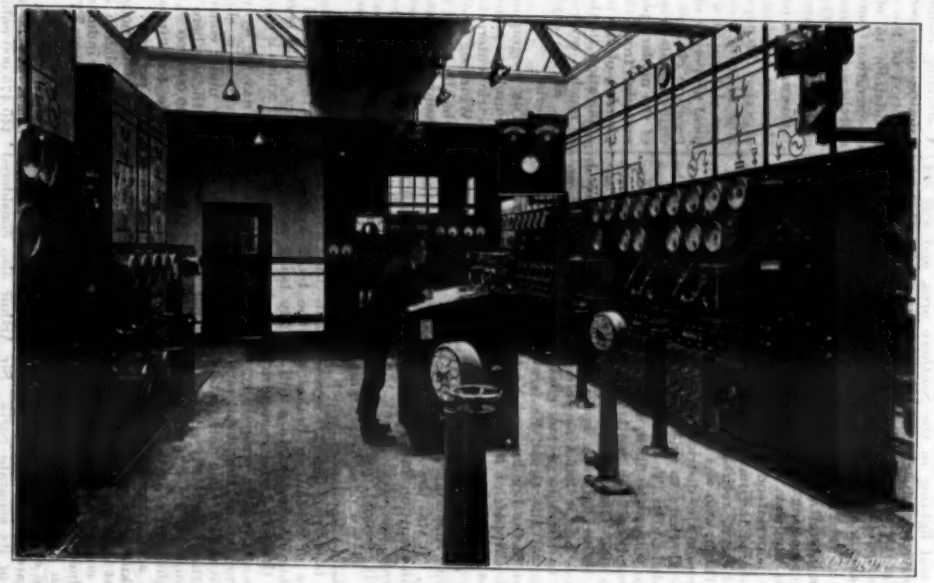

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THE ENGINEER.

JUNE 13, 1924.

Steel in Large Masses.

A QUESTION of some interest was raised in a paper presented last week to the Empire Mining and Metallurgical Congress by Dr. W. H. Hatfield. It related to engineering design calling for very large masses of steel. The view was put forward by the author, and is apparently shared by others closely connected with the production of heavy steel ingots and forgings, that the engineer is, to say the least of it, unwise to adopt designs requiring the production of single pieces of steel of very great mass. "When," said Dr. Hatfield, "ingots of 60, 70 and 100 tons and more are cast, the engineer must realise that whilst in the first place it is really a feat on the part of the works organisation to produce such a large mass, yet having produced that mass, it becomes far more difficult to guarantee its homogeneity. Yet one of the most noticeable features of modern engineering is the blitheness with which engineers will legislate for the use of larger and larger masses of steel." When it is suggested that ingot weights as great as 260 tons may be called for, the soundness of the steel makers' point of view is, of course, obvious, and it can only be supposed that excessive demands of this nature are put forward by engineers very inadequately acquainted with the technology of present-day steel-making practice and with its limitations. A volume of liquid steel sufficient to make such an ingot can certainly be produced, and could no doubt be handled in the largest of our steel works; but its conversion into a single ingot of reasonably satisfactory quality is a very different matter. It is, in fact, obvious that at any given stage in the development of steel works practice, there is a limit to the size of ingot that can be wisely demanded, but the question is at what point that limit should be placed, and, further, whether efforts on the part of steel makers to produce larger and larger masses are worth while, either from their own point of view or from that of the reasonable engineer.

Two sets of countervailing considerations have in such a case to be balanced against one another in order to arrive at a reasonable compromise. On the one hand, we have the demands of engineering practice for units of ever-increasing size, whether we think of the heavy forgings required in shipbuilding or in turbine practice. From the purely engineering point of view, it is in itself a somewhat open question, how far increasing size of unit is in itself economical and desirable. But even in existing practice, the largest machines—such as turbo-generators—already call for single-piece forgings of very great size. The question of pure design we do not propose to discuss here, but rather to consider the secondary problem whether, for a given size of unit single-piece forgings of very great weight should be adopted, or whether the steel makers' counsel to use smaller forgings and build them up into parts of the desired size should be followed. From the simple aspect of design and construction, there can, of course, be no doubt that single-piece forgings are preferable. Mechanical joints are always clumsy and difficult to fit into an elegant design, and involve an increase of total weight and therefore a loss of efficiency in construction. Furthermore, they are costly to make and are never entirely free from all risk of subsequent trouble, and it is very difficult, without employing an excessive weight of metal, to make them as strong as the solid pieces which they hold together. We see, therefore, that in every way the use of the largest possible single pieces is eminently desirable from the constructional point of view. Against these merits, however, must be set the weighty objections and warnings of the steel maker, who points out that with increasing size it becomes correspondingly more difficult to secure uniformity of quality throughout the mass of steel. In the first place, the heavier the mass of steel, the slower will be its natural rate of cooling, and if the molten steel is run into a large ingot mould, solidification will be correspondingly slow. During this excessively slow process of cooling and solidification, segregation is bound to occur, and it is found that the larger the ingot, the more pronounced does this evil become. It is suggested that molten steel is a complex solution from which different constituents must crystallise in turn, and that if the process is unduly slow, the constituents which are least fusible will solidify first in the colder parts of the mass, leaving the more fusible to become concentrated in those regions which retain their heat longest. We are thus increasingly apt to find, as larger and larger ingots come to be produced, a correspondingly increased tendency towards disparities of chemical composition between different portions. Almost worse than this is the difference of physical structure, associated mainly with the non-metallic inclusions which are always present in commercial steel to some extent. With very slow solidification, these inclusions tend to assume most undesirable arrangements which cannot be effectively broken up by subsequent forging or heat treatment, with the result that the homogeneity and consequently the reliability of the steel is jeopardised, or even to some extent definitely sacrificed.

These steel-making considerations, to which must be added the difficulty of satisfactorily heat-treating large masses, undeniably exist in current steel-making practice, and should set a limit to the size of ingot demanded by the engineer. The exact limit, however, differs very markedly as between different steel makers, since the art of reducing the defects just indicated to the lowest possible limit has not everywhere been equally developed. The size of forging which should be employed by the engineer is therefore a matter of compromise, and one to be arranged in individual cases by the close co-operation of engineer and metallurgist. But the engineer's need for large forgings of good quality—a need the grounds for which we have briefly outlined above—should serve as a stimulus to the steel maker to develop improved methods of ingot production, with a view to meeting, step by step, the growing demands of engineering construction. At first sight it may perhaps be urged that there is no way of accelerating the natural rate of cooling of great masses of molten metal, since for the removal of the heat derived from the inner portions we are limited by the thermal conducting power of the steel itself, even if it were possible to cool the exterior much more rapidly than is done at present. That may be so, provided that a given shape of ingot is accepted as the one and only possible form in which molten steel can be allowed to solidify for the production of forgings. But even if this primary limitation is granted, there are other ways of attacking the problem. It is by no means certain that the causes of segregation are really those which are at present widely accepted; the laws governing the solidification of complex solutions under severe temperature gradients have not as yet been fully worked out, and the approximate views now held may prove to be far from the truth. The phenomena of "inverse segregation," where the most fusible constituents may actually be found in those parts of an ingot which were the first to solidify, suggest the need for caution in theorising on such a subject. Furthermore, the methods of filling ingot moulds, which allow of the presence of large masses of liquid steel, may be open to improvement. We can scarcely suggest here either the lines of research or the kind of results likely to be attained; but we

can say definitely that there is room and need for effort on the part of the steel maker and his scientific collaborators, and that the problem of adequately meeting the engineering demands for larger forgings should not be regarded as insoluble or even too difficult to attack. But in the meantime, it is for the engineer to realise and beware of the limitations of existing practice in this respect.

Whither?

THERE has never been a time when the world has lacked men to decry the advances of science, and to proclaim the destruction of all the amenities of life and of all hopes of salvation as a result of its teaching. But for many years the mechanical arts had to suffer but little censure of that kind. The world was all for progress; it welcomed with both hands every new machine that was placed before it, and blamed inventors if they were slow in inventing and manufacturers if they were tardy in adopting new methods of production. Moreover, "there was money in it," and every advanced nation of the world boasted of its power to grow richer by manufacturing and by the development of machines that reduced the amount of labour required per unit of product, whilst enormously increasing the rate of production. It seemed a very satisfactory sort of world up till August, 1914, and throughout the war the knowledge and skill which mechanical engineers were able to bring to the help of the soldiers was lauded to the skies in a careless oblivion of the fact that mechanical engineering had not changed war, but only enlarged its scale and added to its terrors. But with the war well over and with unemployment rampant, the critics have arisen once more, and are asking whither the world is being led by its scientists and its engineers.

We are not amongst those who imagine that engineering industries have passed their zenith, and that never again will this country be able to give employment to all those who desire to follow the variety of trades and professions which are associated under the general heading of engineering and kindred industries. We are therefore confident that in due course the critics will be once more reduced to silence by the noise of machinery and the jingling of money bags. At the same time, we see some evidence that science, engineering, and methods of production are out-running the ability of human societies to adapt themselves to the new conditions, and that in certain respects modifications will have to be met. One of the most obvious is the position of the skilled man in industry. There was a time, not more than a score of years since, when some of our trades unions, notably the Amalgamated Society of Engineers, owed their strength to the fact that they would admit to membership no unqualified men. The need for well-trained and experienced mechanics was then universal in engineering shops, and as such men could always be found in the A.S.E.—to follow up the example we have quoted—that Society enjoyed an enviable position. In those days the members of that Society were good all-round mechanics, and there was a constant demand for them; but to-day the actual number of such men required is relatively small, and A.E.U. men do not stand so high in the opinion of employers as their predecessors, the A.S.E. men did. The Amalgamated Engineering Union maintains its apprenticeship regulations, as do many, if not all, other unions, but the primary object is no longer, as it was in the days of the ancient guilds and of their successors, to maintain a high level of skill, but to limit the number of those occupied in any trade. The bald and brutal fact is that as far as the real needs of industry are concerned, apprenticeship in the old sense is not required to anything like the extent that it used to be. There are many jobs that can be learnt adequately—as dilution during the war proved—in a few weeks or at most a few months, and were employers given a perfectly free hand in the use of machinery, the number would be still further greatly increased. The trades unions resolutely shut their eyes to this fact because it is their policy to do so, just as they insist rigidly on demarcation. They have not accommodated themselves to the new environment; they are still living in the days of half a century ago, and unemployment is the result. What would seem to be needed to meet modern conditions is the establishment of a small class of really highly trained workmen, men of picked intelligence and ability, who had spent a couple of years in schools of technology and who had inherited or acquired the art of leadership. These men would occupy the position of charge hands and foremen, would attend to the setting and maintenance of tools, and would direct and control production without themselves producing. Beneath them would be a class of general craftsmen; men, that is, at liberty to take on any work within their capacity, and not, as at present, prohibited from laying bricks because they happened to be more handy with chisel and saw. In America conditions of this kind prevail to a much greater extent than in this country, and it is for that reason no doubt in a great measure that the employment of machinery is very much higher there than it is here. If we now turn from the class of workmen to that of employers and professional engineers, we shall see parallel changes taking place. The "shop" that used to be the stable conversation of engineers a score of years ago, is far less common than it was; it has been replaced by problems of production, organisation and finance. The standard requirement in the past was a man who knew all about engineering and a little about commerce. Now the position is reversed, and the engineer most likely to enjoy a lucrative position is one who knows all about buying and selling and can reduce engineering to a self-acting manufacturing system. Whether the curricula of our technical schools will have to be modified to suit these new demands, or whether as a whole it can be shown that a liberal education in the science and technology of engineering makes the men best adapted for the requirements of industry, remains to be seen. We must notice, however, a marked tendency to place highly trained men in the sales branch, whilst leaving the production side to men with less technical, but more organising ability.

Whither, we may ask, are such changes as we have indicated leading us? Do they not show that manufacturing is becoming more and more a sociological and not alone an industrial problem—in other words, that we can no longer say, if we look after the industry, the sociology will look after itself? Throughout the whole of last century, there was little or no need to consider the lives and occupations of men, both workmen and employers, *outside* the factory, for nearly all of their waking hours were spent in it. But with the progress of machinery the hours of labour that are necessary to meet the needs of life are reduced, and there is, in consequence, vastly more leisure. How that leisure is spent is now as great a problem as how the hours of labour were spent. Employers have not been slow to recognise this fact, and with the help of Welfare Societies they have, wherever the conditions permit, established recreation clubs of various kinds. But something more is probably needed. The dancing saloon, wireless and the picture palace, even when they are supported by the swimming bath and the sports ground, cannot satisfy in full the requirements of boys and girls, men and women, who have five or six hours of idleness on their hands every day. That is the sociological problem that has to be solved. Without employment of some kind, discontent and unhappiness ensue. It may well be that the right solution is the improvement of the intellectual equipment of the coming generation, and that we shall find it necessary to relax some of our attention to utilitarian studies and devote it to those which tend in a greater degree to enlarge the outlook upon life.

Empire Mining and Metallurgy.

No. II.*

IN the section of the Empire Mining and Metallurgical Congress dealing with the metallurgy of iron and steel eleven papers were included in the agenda. To some of these reference was made in last week's issue, and a brief summary of some of the many points of interest raised in the remaining contributions and discussions may now be given.

IRON AND STEEL METALLURGY.

At the present time attention has been concentrated on some of the economic considerations which are retarding the revival of British industries generally, and those which affect the iron and steel trades were dealt with in papers, the authors of which were Sir William Larke and Mr. M. S. Birkett. It is shown in this contribution that the depression which now exists in the iron and steel industry is not inherent to it, and that home works were never better equipped than at the present time. Yet it is difficult to get out of the trough of depression. Arguing from the rate of growth in the first decade of the twentieth century, the world ought now to be consuming 105,000,000 tons of pig iron a year; the present rate of consumption is only 65,780,000 tons. Some progress towards recovery has already been made, but Great Britain must, we are told, be prepared in the immediate future to face intensified competition. Belgium, with a capacity of production only a quarter of that of Great Britain, has already built up a considerable export trade, and last year exported to Great Britain more iron and steel than in any year before the war. France, having obtained possession of the magnificently equipped iron and steel plants of Lorraine, will, it is believed, become a strong competitor in foreign markets. The competition to be expected from Germany can best be envisaged by a consideration of the fact that German industrialists have been able to impose upon their workpeople much longer hours with much lower wages than are the custom in Great Britain. It is reported that a sixty-hour week on night shift, fifty-eight hours on day shift, and fifty-seven and a-half hours in finishing plants are being worked on wages which in English currency represent for skilled workers 6d. per hour. Until now the large home demand had prevented the full force of American competition being felt in export markets, but the opinion is expressed and it is known to be well founded that in times of restricted demand United States manufacturers will endeavour to dispose of surplus output in the export market. It is true that the relations between capital and labour are more harmonious in the iron and steel trades than in any other industry, and that labour has taken its full share in the reduction of prices which severe competition has forced the industry to accept. It is regarded as doubtful, however, whether the industry can regain real prosperity without a further decrease in labour costs. It is pointed out that this does not necessarily mean either increased hours or decreased earnings, but does imply that the output per man-hour must be improved. The Dominions could, it is said, assist the development of the iron and steel industry, not merely by granting a preference to British goods, but by the insistence of equally stringent tests being applied to material offered from other sources as is applied to material from British sources and by an insistence in the case of imports from foreign countries on the clauses which apply to British material in regard to wages and conditions oh labour.

An interesting general technical review of the British iron and steel industry was presented by Mr. F. W. Harbord and Mr. E. F. Law. The paper stated that there is probably no iron-producing country in the world where within such a small area conditions vary so much in respect of raw materials as in Great Britain. The authors can find no fundamental inventions since the introduction of regenerative stoves in blast-furnace practice and the Bessemer and open-hearth processes, acid and basic, which have vitally affected the industry. The modifications in practice which are noted are developments based on existing methods rather than new discoveries. The acid Bessemer process, although still holding its own in certain districts, has had, like the basic Bessemer, to give way to the open-hearth process. The industry was made to realise its weak points during the war period, and in most districts modern works specially designed to meet local requirements have been erected and equipped with the most modern labour-saving appliances. These establishments, when operated at their full capacity, should, it is believed, be able to compete with the most modern plants in other countries. The total capacity of British steel works, which in the years before the war was approximately 9,000,000 tons per annum, has been increased to about 12,000,000 tons. For many years British manufacturers have produced pig iron from lower-grade ores than are smelted in any other country—ores containing only from 19 per cent. to 25 per cent. of iron—and this pig iron is made in competition with the world at a profit. The authors conclude with an expression of their belief that the technical knowledge and experience of those engaged in the home industry will enable them not only to hold the home markets, but to maintain and extend export trade in foreign countries and to supply the Overseas Dominions with materials, which at present they do not produce, at prices which will offer successful competition with the whole world.

ALLOY STEELS.

A broad survey of the development of alloy steels was given by Sir Robert Hadfield. The alloys dealt with were manganese steel, silicon steel, and some of the more modern varieties, including non-corrodible steels. It is pointed out that the extent of the progress made by steel metallurgists in the campaign against corrosion is perhaps not fully realised by engineers, who would find that in many cases suitable steels are already available, or at least steels better than those at present employed from the point of view of mechanical properties under the working conditions concerned. For structural work as distinct from machinery Sir Robert comments on the comparatively small use which has been made of alloy steels, among which he instances nickel steels and chromium steels as having excellent physical properties, and as being easy to machine and comparatively cheap. He, like all who have given attention to this branch of metallurgy, regards the field to be covered as still very large, notwithstanding the remarkable advances already made in the study of and the employment in service of alloy steels.

Dr. W. H. Hatfield, dealing with modern developments in the metallurgy of special steels, claimed that

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investigations of recent years have done much to explore the physical chemistry of the reactions occurring between molten steel and steel-making slags, with the result that in an adequately controlled plant the liquid steel issuing from the furnace is usually in a satisfactorily refined and purified condition. Questions of segregation arise in many cases, however, and the bigger the ingot the more important do the questions of segregation and complete ingot soundness become. Yet one of the most noticeable features of modern engineering is the blitheness with which engineers will insist on the use of larger and larger masses of steel. This is nowhere better illustrated than in the case of the construction of turbines. Turning to a very different branch of engineering, Dr. Hatfield dealt with the application of alloy steels to a greater extent in connection with bridges and similar structures. Generally speaking, the engineer has been content to rely upon ordinary structural steels of low carbon content, but the development which has been made in the metallurgy of special steels encourages the hope that civil engineers will see in the future that special steels are employed to a much greater extent. In connection with tool steel it is pointed out that new high-speed steels have been developed and the researches have particularly contributed to show the very great advantage of correct treatment. It has been established that within, for instance, that range of hardening temperatures employed in practice the efficiency of the tool may vary 100 per cent.

Cast Iron.

In a review of the work of the British Cast Iron Association given by Mr. J. G. Pearce satisfaction is expressed that the value of the industrial research worker whose function in an industrial organisation is to ensure that the industry with which he is associated makes the fullest use of new developments is now being generally recognised. The formation of large groups of British manufacturers during a recent period has enabled research facilities to be provided on a generous scale, and it is no exaggeration on the part of Mr. Pearce to claim that investigations are now being conducted in Great Britain which are comparable with the work done by the industrial groups in America and Germany. In the British ironfounding industry operatives have shown so high a degree of manual skill and foremen and managers such resource as to make them largely independent of scientific knowledge. The position is, however, known to be changing. The future line of development does not lie in a mere increase in the quantity of cast iron, but in the improvement of the material to meet special service requirements. The Research Association which has now been formed only came into existence two years ago, but it has already done useful work, although it does not at present possess its own laboratories. The researches now in hand at various universities and elsewhere include investigations of the fundamental properties of cast iron, properties of moulding sands, production of automobile castings, high temperature castings, corrosion resisting cast iron, influence of nickel and chromium, electrical and magnetic properties, study of failures, development of particular irons to meet special specifications, and a fundamental research upon malleable iron and other varieties designed to increase the knowledge available of these materials.

What is being done in Government laboratories in metallurgical research was described by Dr. J. L. Haughton. He reminded the Congress that, although a certain amount of work is being carried out at the Research Department, Woolwich, at the Mint, and at the Admiralty Engineering Laboratory, the National Physical Laboratory was the only Government establishment where pure metallurgical research is carried out mainly for the advancement of knowledge. The work, as Dr. Haughton indicated, is of a very varied character, including researches on light alloys, effect of heat treatment and composition on the magnetic properties of tungsten steel, effect of mass on the heat treatment of nickel steel, die casting of aluminium alloys, physical constants of metals, X-ray analysis of the crystal structure of metals, and causes of failure in engineering materials.

In an account of the position of the iron and steel industry in Canada, Mr. C. S. Cameron said that in Eastern Canada and Newfoundland there are unlimited supplies of ore and coal, and the nucleus of a very important branch of the industry.

The outlook for developments in India is, in the opinion of Mr. H. M. Surtees Tuckwell, very favourable. While many countries are being forced to the use of the lower grade materials, India has, he reminded the Congress, practically untouched fields of the richest iron ore. With this great asset and the advantage of cheap fuel and labour and low railway rates, India is regarded as certain before very long to become a very large producer of iron and steel, provided necessary and adequate facilities are granted against unfair competition.

Alloys of Aluminium.

In a joint contribution by Dr. W. Rosenhain and Mr. S. C. Archbutt, an account was given of the work which has been carried out on the light alloys of aluminium. It is claimed in this review that observations extending over a long period of years on the constancy of dimensions of castings and their behaviour in service have removed the doubts which prevailed as to the stability of aluminium rich alloys in general. The permanent stability of a large range of light aluminium alloys is held to be now well established. The aluminium alloys at present in general industrial use are shown to be confined to comparatively few types of composition. These include two binary alloys of aluminium with copper, containing from 6 to 8 per cent. and 12 per cent. of copper respectively; and a ternary alloy with copper and zinc, containing about 3 per cent. copper and 12 to 14 per cent. zinc, which are used very extensively. Binary alloys with silicon have lately come into prominence for castings, owing to the discovery of a method of treating the molten alloys which causes them to solidify with a fine-grained structure. The resulting castings are very sound and of good appearance, and combine reasonable strength with good ductility. Two compositions are principally used with silicon contents around 9 and 13 per cent. respectively. An alloy more complicated in type than those above mentioned, and having the normal composition magnesium 1.5, nickel 2, copper 4 per cent. (aluminium remainder), first developed as a casting alloy at the National Physical Laboratory, is now finding extended use. No outstanding improvements in cast alloys have been effected by the many other compositions tried.

In wrought alloys, duralumin still largely holds the field, but reference is made by the authors to other wrought alloys. One, consisting of aluminium, with 3 per cent. of copper and 26 per cent. of zinc, known as the A alloy, and the other with similar contents of copper and zinc, but with a small amount, 0.5 per cent., of magnesium and manganese.

The ratio of strength to density in light aluminium alloys is a useful measure of the comparative value of the materials for constructional purposes. One of the most valuable discoveries to which reference is made in connection with these alloys and their industrial application has been in connection with the mechanism of age hardening.

Oil Fuel Problems.

The subject of obtaining supplies of oil fuel from Empire sources is one of outstanding importance. At the present time the production of petroleum in the Empire—taking the estimated figures for last year—is, according to statistics submitted to the Conference by Mr. A. G. Dunstan and Mr. James Kewley, 514,000,000 gallons, out of a world production of 34,978,000,000 gallons. India and Sarawak are the main Empire sources of supply.

Sir Frederick Black, who discussed the question of bulk distribution of oil, showed that notwithstanding the rapid increase in the world output of oil—the crude oil production rather more than doubles every ten years—it is still only 11 per cent. of the coal production, and oil cannot, it is thought, ever completely supplant coal as fuel. The largest consumption of heavy fuel oil is in railway and industrial service in the United States. The consumption of fuel oil for ships' bunkers—excluding warships—was about 11,000,000 tons last year, and at the present time about 27 per cent. of the world's mercantile tonnage—including motor ships—use oil for power-raising requirements. This development has made it necessary for Great Britain to pay special attention to the storage and distribution of fuel oil at home ports and to establish oil-bunkering stations on the principal trade routes. In meeting these requirements valuable work has been done. Of the 300 oil-bunkering stations now established in various ports of the world, twenty-five are at home ports, forty at other ports of the British Empire, and Great Britain either owns or has interests in a number of oil installations elsewhere. The world's heavy consumption of fuel oil for marine bunkerings is still a comparatively small proportion of the total production, thus admitting of interchangeability between demands ashore and afloat. The question of providing adequate storage raises economic considerations. There is a point at which the advantage of creating reserves is more than counterbalanced by the cost of tanks and the locking up of capital.

What has been done to provide for the needs of oil transport in bulk to meet the requirements of storage plant was described by Mr. Herbert Barringer. The first vessel designed and built in Great Britain for the carriage of oil in bulk was the iron sailing vessel Atlantic, which was launched at Rogerson's yard, St. Peter's-on-Tyne, in 1863. No records of her career have been found. The pioneer tank steamer was the Vaderland, built by Palmers in 1872, but it was not until the late 'eighties that any real activity in the building of tankers was shown. The original Narragansett was built by Scotts for the American Oil Company in 1903. This ship was 512ft. long and had a capacity of 11,000 tons of oil. The machinery and boilers were placed amidships, as it was not at that time believed that a vessel of the size of the Narragansett would be satisfactory if her machinery equipment were placed aft. These fears proved, as is now well known, to be groundless, and tankers of 18,000 deadweight have been built with the boilers and engines in the after position, an arrangement which has reduced the cost of construction and is associated with other advantages. Mr. Barringer traced the development of vessels for the carriage of oil in bulk up to the latest types of Isherwood ships and the newer Miller design.

In the course of an interesting review of the problems associated with mechanical coal mining, Mr. Sam Mavor commented on the surprising fact that in spite of the economic capabilities of machine-mining proved by daily practice, nearly 90 per cent. of the coal raised in England is still being got by hand and man-handled in trams.

SIXTY YEARS AGO.

In our issue of June 10th, 1864, we published a lengthy paper on the chemical history and application of gun-cotton, which Professor Abel had read before the Royal Institution. The history of this substance, Professor Abel said, afforded an interesting illustration of the facility with which the full development of a discovery may be retarded by hasty attempts to apply it to practical purposes before its nature had been sufficiently studied. Schönbein announced his discovery of the new explosive compound in 1846, and lost little time in submitting it to the German Confederation. A committee was appointed by that Government to investigate the explosive, but it eventually declared that gun-cotton was inapplicable as a substitute for gunpowder. In this country experiments were undertaken at an early date with Schönbein's explosive, and its manufacture on a considerable scale was begun by Messrs. Hall, the gunpowder makers, at Faversham. Soon afterwards, however, a disastrous explosion, involving the loss of a number of lives, occurred at the Faversham factory, and the jury having traced its cause to the spontaneous ignition of the gun-cotton, its manufacture on a considerable scale in this country was dropped, and little further experimental work done with it until 1854. In France the manufacture of gun-cotton was also begun at an early date, but three explosions at the Bouchet works, one in 1847 and two in 1848, put an end to the work for several years. In 1852 the Austrian Government investigated the explosive, and subsequently began its manufacture on a small scale. It fell into disfavour with artillerists, however, on account of its lack of uniformity, and its use, except for mining purposes, was abandoned. After the Italian War it was again taken up, and thirty batteries were equipped with guns especially designed to employ it. In 1862, however, it was again abandoned, as an outcome of an explosion which occurred in a magazine near Vienna. In 1854 Hadow in this country definitely established the chemical constitution of gun-cotton, and in 1862 a Committee of the British Association began to experiment on its manufacture, chemical constitution and stability. Subsequently, the War Office investigated its properties, with reference to its military, naval, engineering and industrial uses. In the course of his paper Professor Abel attributed the lack of uniformity and the instability of the early samples of gun-cotton to incomplete conversion of the cotton into trinitrocellulose, as a consequence of insufficient time being allowed for the nitric and sulphuric acid mixture to penetrate into the fibrous mass. He held that the manufacture of gun-cotton was much safer than that of gunpowder, and that there was no possibility of accident with it until the final drying process was reached. The safe preservation of the substance was, however, a different matter. While specimens of Schönbein's gun-cotton, prepared in 1846, were still in existence in an unchanged state, other samples, believed to have been perfectly purified, had been found to have become extremely acid by decomposition.

NORTH-EASTERN WERKSPOOR DOUBLE-ACTING MARINE OIL ENGINE.

In our previous articles of May 30th and June 6th, we referred to the fuel consumption tests which were carried out by Professor Hawkes and his staff. By the courtesy of the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne, we are now able to give the results of the tests, which were made at the beginning, middle and end of the twenty days' non-stop run. These are as follows:—

Date of trial	10/5/24	16/5/24	22/5/24
Duration of test	4 hours	4 hours	4 hours
Revolutions per minute	93.7	93.4	93.9
Indicated horse-power	730	730	725
Brake horse-power	585	592	598
Mechanical efficiency, per cent.	80	81	83
Fuel consumed in lb. per B.H.P. hour	0.428	0.423	0.424

During the trials three different grades of Diesel fuel oil were used, and the oil, we learn, was pumped into the ready-use tanks exactly in the same state as it was delivered in bulk by the oil companies.

The following table gives the chief characteristics of each class of fuel used:—

Type of fuel	A	B	C
Specific gravity at 60 deg. Fah.	0.882	0.871	0.888
Viscosity Redwood at 100 deg. Fah., secs.	47.8	36.0	64.6
Flash point in deg. Fah.	193	185	184
Calorific value in B.Th.U. per lb.—			
Gross	19,364	19,420	19,278
Net	—	18,160	—
	Per cent.	Per cent.	Per cent.
Ash	0.017	0.001	0.009
Water	under 0.05	under 0.05	0.50
Hard asphaltum	3.30	Nil	0.815
Sulphur	1.42	0.27	1.18
Carbon	86.57	87.16	86.31
Hydrogen	11.96	12.62	11.71
Nitrogen	0.15	0.16	0.16
Oxygen	Nil	Nil	0.13

Since it was opened out, the engine has been carefully inspected and it was we learn found to be in first-class condition in every respect. The gauge readings, which were taken on the piston and liner, showed that wear was an entirely negligible quantity. All piston rings and piston-rod packings were entirely free in their grooves, and throughout the trial they remained in a properly lubricated condition.

The New Dry Dock at Havre.

THE important extensions of the Port of Havre, which were sanctioned by the Law of February 11th, 1909, included, among other things—

(*a*) The construction of outer breakwaters, 4 kiloms. in length;

(*b*) The building of a deep-water quay, 1000 m. in length; and

(*c*) The provision of a new dry dock with a useful length of 312 m. (just over 1023ft. 6in.).

It is with the last item that we propose to deal in what follows. For some of the particulars and for the illustrations reproduced, we are indebted to a description of the work which appeared in a recent issue of our contemporary *Le Génie Civil*, while much useful information has been derived from a paper by Monsieur Maurice Michel-Schmidt, which was presented to the British Section of the Société des Ingénieurs Civil de France at a meeting held in London on June 3rd.

The official requirements specified for the dry dock were that it should be capable of taking in vessels 300 m. in length, with a beam of 37 m., and a draught of 13 m. with water in the tidal basin assumed to be at + 5.25 m. above datum, which was taken as zero of the marine charts. Actually, the dock, as constructed, has a length, as above stated, of 312 m., and a free width at the entrance of 38 m., say, 124ft. 8in. As a matter of fact, that width is greater than is actually necessary for vessels only 300 m. long, corresponding as it does to vessels having a length of 340 m., and the possibility of increasing the length by another 50 m. has been kept in view. Such increase would bring the total length up to 1187ft. 9in. The level of the sill is 8 m. below datum, so that with water at 5.25 m. above datum, the depth of water over the sill is 13.25 m., or very nearly 43ft. 6in.

There was, before the actual type of dock to be constructed was decided, a good deal of discussion as to whether the structure should be floating or fixed. Eventually, for reasons into which we need not enter here, the dry dock was chosen, and the problem then to be decided was, How was it to be built? The matter was complicated by the fact that the whole area of the site to be occupied was below the low water line. We need not discuss in detail the various schemes proposed, but will go on to describe that which was adopted and carried into effect. It was the joint suggestion of Messrs. Schneider, Vigner and Michel-Schmidt, and was of an exceedingly venturesome character, consisting as it did of forming the dock inside a single gigantic caisson, measuring no less than 345 m. (1142ft.) long by 60 m. (196ft. 10in.) wide. This huge structure, which was composed of steel and concrete, was erected on land, floated, towed to the site it was to occupy and then gradually sunk on to a previously dredged foundation by building masonry inside it, so as to form the walls and floor of the dock. The project deserved to succeed—as actually it has—if only on account of its daring nature, but it called for a high standard of skill and workmanship to make it successful.

The methods employed throughout were of considerable interest. In the first place, a sufficient area of water in a tidal basin had to be enclosed by a polygonal cofferdam in one side of which, to begin with, an opening 12 m. (say, 39ft. 5in.) wide, and with its sill at 3.8 m. above datum, was left for the passage outwards of barges, &c., containing spoil from the excavation of the foundation, and for the passing in of the plant necessary for use during construction, such as floating sheer legs, pontoons, barges, lighters, &c. The shape of the enclosure and the relative positions of the erection site of the caisson, the final site of the dock, and of the outlet from the enclosure are shown in Fig. 1. At a later stage the outlet was closed by blocks of concrete, each weighing 80 tons, and by means of channels, with their inverts 1.0 m. above datum, taken through the lower portion of the cofferdam mole and furnished with inner and outer hinged flaps, the water could be drained from the enclosure at times of low tides, a powerful pumping plant being installed still further to reduce the water level when it became necessary to do so. Figs. 2 and 3 show how these arrangements were effected.

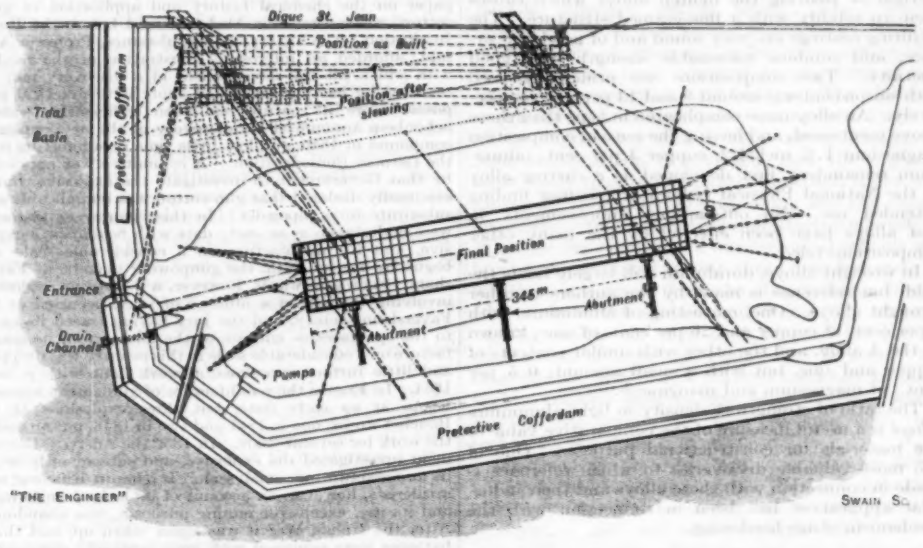


FIG. 1—PLAN SHOWING POSITIONS IN WHICH THE CAISSON WAS BUILT AND SUNK

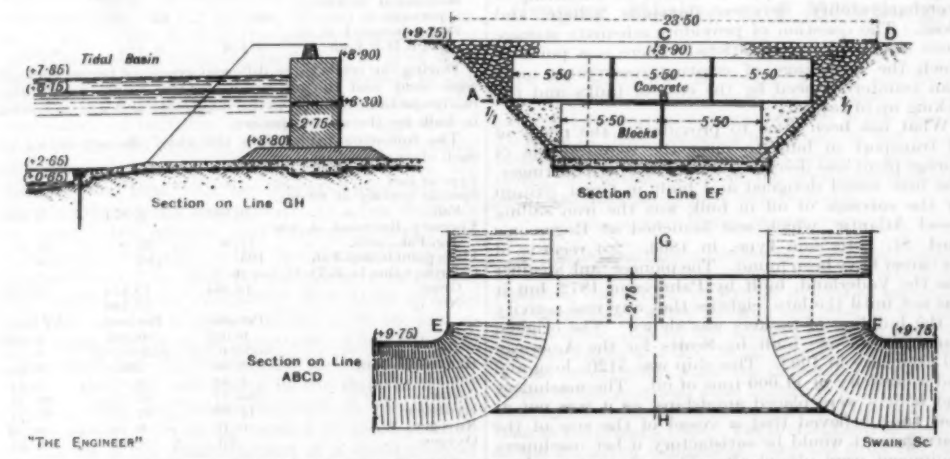


FIG. 2—PLAN AND SECTIONS OF ENTRANCE WAY IN COFFERDAM

The work of dredging the foundation, which was taken down to a depth of 20 m. (65.6ft.) below datum, and which was carried out by the firm of Ackermans and Van Haaren, was begun as long ago as July, 1911, and completed in April, 1914. In order that no difficulties might be encountered from the heavy tides when dredging at such a depth, the work was done in layers of approximately 3 m. over the whole surface, and, as a matter of fact, the last layers were dredged after the completion of the cofferdam. It is said that a remarkably fine bed or floor was obtained, but unfortunately, owing to the long interval between its completion and the time when the caisson was ready to be sunk, a good deal of dredging had to be done at the later date.

The preparation of the steel framework, which was used in the construction of the caisson, was entrusted to the Schneider Company, which began it at its Chalons-sur-Saône works some time before the outbreak of hostilities, and erection at Havre had reached an advanced stage when the war came and put an end to operations, which were not resumed until after the Armistice. Siemens-Martin mild steel of especially great elongation was employed, and great care was taken in the construction of the main elements, edges being planed and holes drilled, hydraulic or pneumatic riveting being employed throughout. For those elements, however, which had only to secure water-tightness, the holes were punched and flat-headed rivets were permitted.

The framework of the caisson was built up first of all by laying down a series of transverse girders, 6 m. (say, 19.7ft.) in depth, and of the simple Warren type. These girders were arranged parallel with one another, and were spaced at 8 m. (say, 26ft. 3in.) centres. They were connected up longitudinally by a second series of girders, of the same type and depth, spaced at about 11.0 m. centres in the central portion of the transverse girders and at nearly 7 m. centres

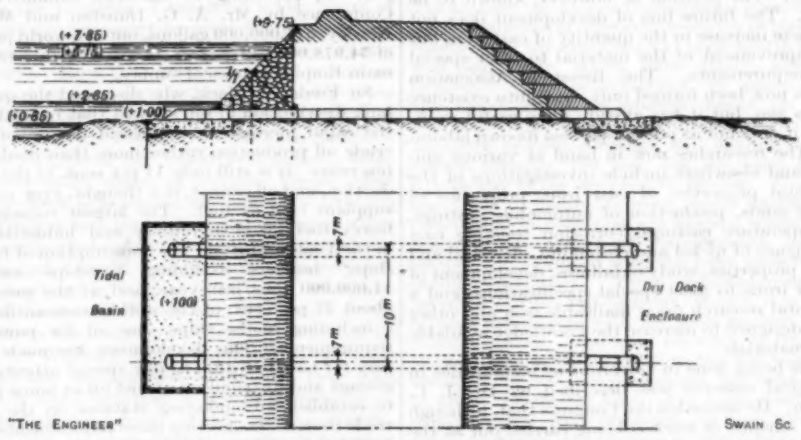


FIG. 3—SECTION AND PLAN OF DRAIN CHANNELS

at the sides. The bracing of the floor was composed of small lattice work Warren type girders, 1 m. deep, spaced at 1.1 m. centres, and arranged parallel with the main longitudinal girders. At each end of each transverse girder there was fixed a triangular steel column or post, and all the posts on each side were connected together by horizontal tie-beams, 1.15 m. deep and spaced 1 m. apart. These columns or posts were used for attaching the side plates, the duty of which was to act as bulkheads and make the side of the caisson water-tight, and which were built up, metre by metre, as the caisson was gradually sunk.

The main longitudinal and transverse girders, which formed the keelsons and frames of the ship-like structure, were enclosed in rich concrete mixed in the proportions of 800 litres of gravel, 400 litres of sand to 300 kilos. of Portland cement. The general arrangement of the structure will be seen from the half cross sections of the finished dock, given in Fig. 4. The floor plating, which is only 4 mm. thick, was covered to a depth of 0.4 m. with rich concrete. The side plating was also covered inside with a thickness of 1.25 m. of concrete of the same quality, which was also made to envelope the small tie-beams, so that the whole formed a very rigid mass of reinforced concrete.

A cross section of the structure of the caisson in course of erection is given in Fig. 5, and from it an idea of the skeleton framework may be obtained. It is somewhat difficult, however, to form a correct conception of the size of the structure, which, it must be remembered, was no less than very nearly 200ft. wide. Having regard to the considerable weight which would have to be built into the hull before it was ready to be water-borne, it was decided

to erect the framework on a large number of dwarf pedestals or stools, composed of reinforced concrete, and formed on the heads of driven piles. There were eleven of these stools to each transverse girder, and on them were fastened blocks and wedges of hard wood, which served as supports for the bases and gave a certain amount of play for expansion and contraction. How necessary it was to have some such arrangement may be gathered from the fact that, when sufficiently far advanced to be water-borne, the caisson weighed no less than 46,000 metric tons, of which 6000 tons represented steel work and 40,000 tons concrete. The most difficult part of the erection work consisted in pouring, while the caisson was still "on the stocks," so to speak, of the large volume of concrete, which represented approximately 17,000 cubic metres, in such a manner that the whole structure might have a certain amount of rigidity when it was floated. The operation was, however, effected so skilfully and the calculations for and disposition of the weight had been so accurate, that the caisson when water-borne floated on an absolutely level keel. The whole matter was complicated by the fact that a large part of the structure had been in position for a great length of time, with, consequently, some measure of adhesion between it and the supports on which it rested.

It was decided that the entrance to the dock when completed should be closed by means of a caisson gate—as shown in Fig. 6—and, in the main caisson inside which the dock was built, the opening which was to form the entrance to the dock, and that in the north wall of the dock through which the caisson gate will pass to and fro, were closed by means of temporary bulkheads. It being desired to use the dock either as a dry dock or a wet dock, it was necessary to have a pair of lock gates arranged to close the floating caisson-gate passage way. The leaves of the gate, it will be noticed, are of unequal size, and were so made to reduce to a minimum the stresses on the entrance pier, which, it will be realised, is isolated.

When the time came for floating the huge caisson into position, water was admitted into the enclosure inside the cofferdam to a depth rather greater than than calculated to be necessary to float the structure. As it was impossible that the area inside the cofferdam could be flooded to the desired depth in one tide by simply removing the concrete blocks, which, as explained above, were used to stop up the opening left in one of the walls of the cofferdam, it was decided to remove only the upper row of blocks, which left the level of the sill at 6.3 m. above datum, and only to remove that row when the water, which had been allowed to enter through the drainage channels, had reached that level—an operation which took four tides. The final filling to a depth of 7.60 m. above datum was apparently done in one spring tide—when the sea level reached a height of 8.0 m. above datum—the entrance and the channels as well being employed to admit the water. When the desired level was reached, the blocks were replaced in the entrance and the latter made carefully water-tight, so that the level of the water inside the cofferdam might be maintained.

When all was ready, the caisson was first of all slewed through a small angle by means of winches and cables, and then hauled to immediately over the spot it was to occupy, the exact position being defined by means of three abutments, consisting of strong beams floated on rafts and held by piles, which had previously been put in place. The caisson was securely moored up against these abutments, and it remained touching them during the whole operation of sinking. The abutments, in fact, were employed to observe if the sinking was being carried out equally. A very great deal of study had been devoted to devising and perfecting the hauling or towing arrangements, and, as a result, the work of transferring the huge floating mass through a distance of some 650ft. was carried out without a hitch and most expeditiously on August 16th, 1920, the whole business only taking about six hours.

For building the caisson on shore, for placing the concrete in it to give it weight and rigidity, and afterwards when building in the masonry during the sinking, overhead ropeways, which had a total capacity of 500 cubic metres per day of eight hours, were employed—see Fig. 5. The regularity with which these ropeways worked and their high efficiency proved to be of great help in the ballasting operations. The work of sinking took nearly two years to complete, not being finished until June, 1922. Great care was exercised in depositing the weight symmetrically, so as to keep the structure rigidly on a level keel. The foundation, as has been explained, had been dredged down to 20 m. below datum. When the depth of immersion just exceeded 18 m., or, say, 59ft., the water level, which had during the progress of sinking, been gradually lowered to datum, was further lowered to 2.5 m. below datum. The effect of this reduction was, of course, to allow the caisson to ground, which it did very fairly evenly, in spite of the inevitable deposition on the floor of the foundation of a carpet of mud and silt. The silt, &c., which was found inside the chambers formed by the transverse and longitudinal beams, was evacuated by suction dredging and the spaces filled up with hydraulic lime concrete deposited under compressed air, air locks, of course, being employed for the purpose.

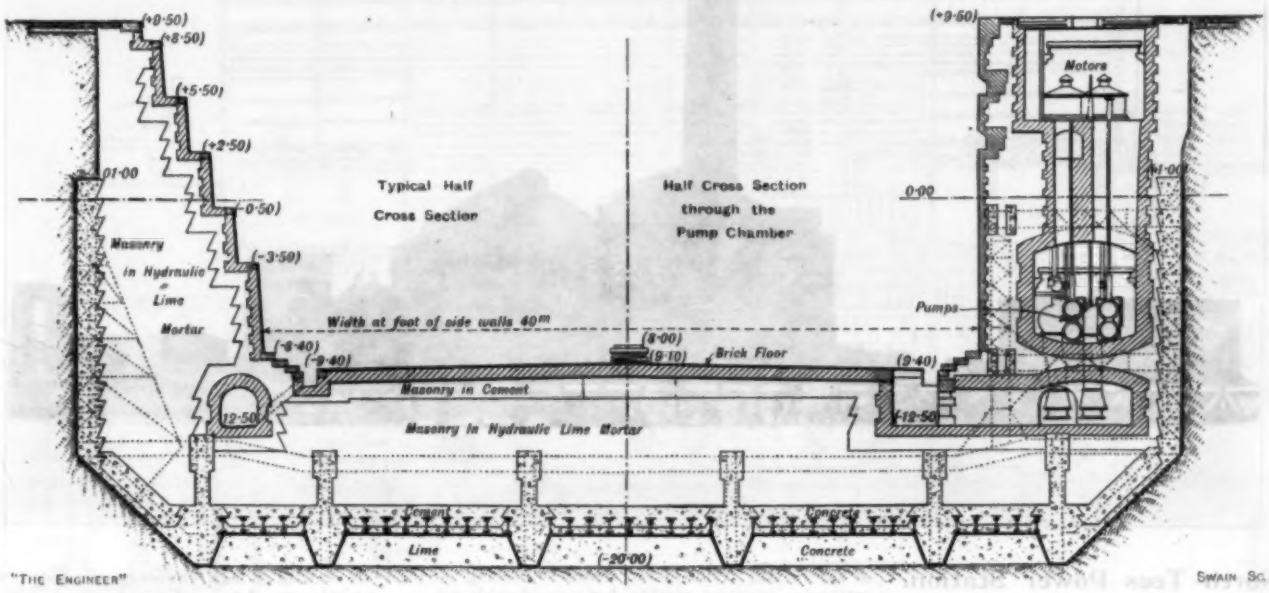


FIG. 4—HALF CROSS SECTIONS OF DRY DOCK

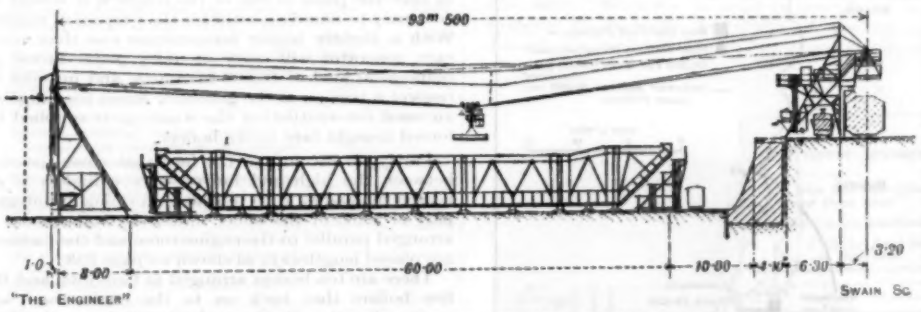


FIG. 5—SKELETON STRUCTURE OF CAISSON AND OVERHEAD ROPEWAYS

The different materials used in building the structure of the dock inside the caisson are shown in Fig. 4. As will be seen, the top of the dock wall is at a level of 9.5 m. above datum. Since the foundation level was 20 m. below that line, the total height from top to bottom is no less than 29.5 m., or, say, 96ft. 9in. The dock does not, of course, remain isolated and surrounded by water. To the west it became necessary to construct retaining walls along the shore. The north side was to become the connecting link between a quay named Joannès Convert—which runs parallel with and to the seaward of the Digue St. Jean—and the chamber for containing the floating gate when the dock is open; while the south side will be a berth for small vessels and tugs. The north connecting wall had its foundation on a single caisson, 48 m. by 14 m., sunk to 20 m. below datum. This process required a great deal of care, for the north end rested on material deposited by the dredgers, which gave the mass a tendency to slide towards the wall of the dock. The south wall is a simple structure of reinforced concrete, which, first of all, adds 26.5 m. in length to the west side of the south pier at the entrance to the dock, which, it may be explained, faces nearly due west. The wall then turns back at right angles for a distance of 35 m.

Much more might be written concerning this most interesting undertaking, but lack of space prevents us from saying more in the present instance. Messrs. Schneider, Vigner and Michel-Schmidt are to be congratulated on the successful termination of a project which is alike noteworthy for its daring and for the remarkably skilful manner in which it was carried out.

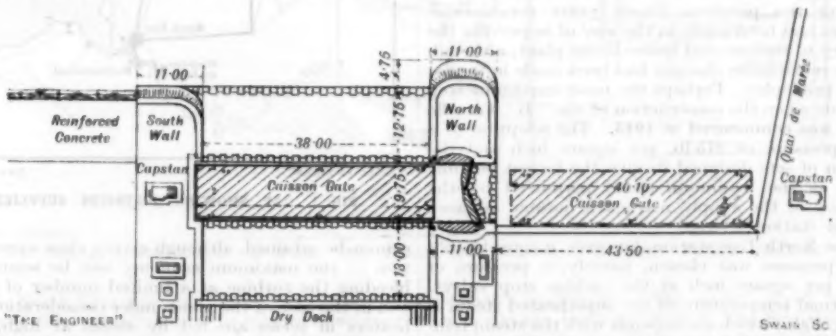
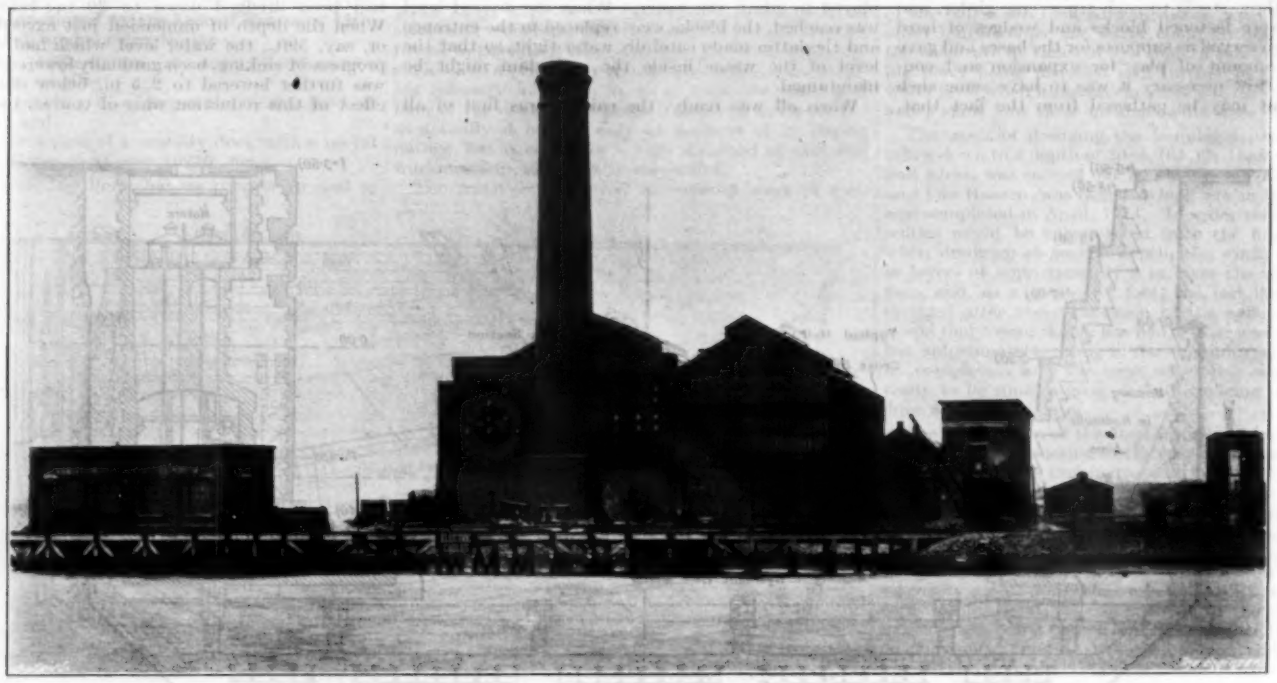


FIG. 6—FLOATING CAISSON GATE

A NEW diamond "pipe" is said to have been discovered, at a depth of 230ft., near the Premier Mine in South Africa.

THE NORTH TEES ELECTRIC POWER STATION



The North Tees Power Station.

THE North Tees generating station, which, as most engineers are well aware, differs in several respects from other power stations, constitutes the latest addition to the plant of the North-Eastern Power Companies. For many years past these associated concerns, now controlled by the Newcastle-upon-Tyne Electricity Supply Company, have been developing a uniform system, and at the present time the total area dealt with in Northumberland, Durham, and the Cleveland District of Yorkshire is something like 1400 square miles. The map Fig. 1 shows the main transmission network and also the position of the North Tees station, an exterior view of which is given above.

In 1917 the Newcastle-on-Tyne Electric Supply Company completed arrangements for the operation and management of the whole of the associated company's undertakings. Prior to that time nearly all of the coal-fired generating plant of the North-East Power Company was concentrated on the Tyne in the Carville and Dunston stations, although a considerable proportion of the output was provided by waste heat stations at various collieries in the Durham coalfields, and at several iron and steel works on the Tees. A small coal-fired station at Grangetown supplemented the waste heat supply, and during the war the increased loads were largely dealt with by transmitting energy from the two main stations on the Tyne.

When the question of building a new station arose and a site had to be chosen it became evident that the most suitable locality for the station was in the Tees area, where, apart from the slight disadvantage of having to transport the coal over a longer distance, generating conditions are equal to those on the Tyne. In view of the rapid development of the Carville and Dunston stations and the prospect of similar development on the Tees, a site with an area of 56 acres and a river frontage of 2000ft. was acquired on the north bank of the Tees.

During the previous fifteen years considerable advances had been made in the way of improving the efficiency of turbine and boiler-house plant, although no very remarkable changes had been made in fundamental principles. Perhaps the most important step was made when the construction of the "B" Carville station was commenced in 1913. The adoption of a steam pressure of 275 lb. per square inch and the selection of sets designed to give the largest possible output at the maximum speed permitted by the frequency of the supply marked a notable advance to power station design.

At the North Tees station, however, a considerably higher pressure was chosen, namely, a pressure of 450 lb. per square inch at the turbine stop valves. The normal temperature of the superheated steam is 700 deg. Fah., which corresponds with the steam temperature at the "B" Carville station, for this appeared to be about the maximum temperature that can be adopted with the ordinary materials that are available. It was also decided to re-heat the steam during the course of expansion in the turbines. Dr. Ferranti pointed out a good many years ago that an appreciable gain should arise from the practice of supplying heat to the expanding steam so as to keep it continuously at the maximum temperature up to the point at which, when expanded to the minimum pressure in the condenser, it would just be at the point of saturation. Continuous steam re-heating during expansion is impracticable, but considerable advantage can be derived from the practice of re-heating at one point in the expansion, and in the design of North Tees station this plan was adopted.

It was also decided to bleed steam from the turbines for the purpose of heating the feed water and to use the heat in the flue gases for heating the incoming air to the furnaces, a scheme which, of course, is now becoming common practice. As in the case of steam re-heating, steam bleeding for feed heating should really be done continuously throughout the turbine. In practice, however, this theoretical ideal

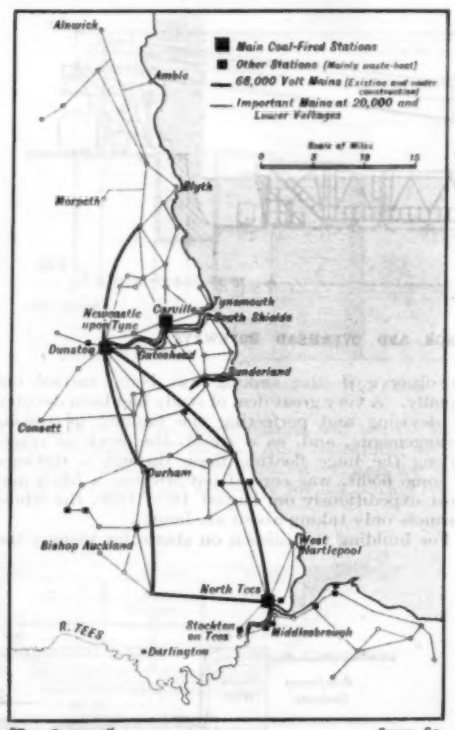


FIG. 1—MAP SHOWING DISTRICTS SUPPLIED

cannot be attained, although a very close approximation to the maximum economy can be secured, by bleeding the turbine at a limited number of points, and in the case of the plant under consideration three heaters in series are fed by steam at high, intermediate, and low pressures, these heaters being supplemented by two other heaters supplied with steam from the turbine glands and from the drains, as shown in Fig. 2, which also shows the pipe connections for the steam re-heaters, which take the place of the ordinary integral economisers on five of the boilers, as shown in the drawing Fig. 3. Four views of the station are also given on page 658.

The conditions prevailing on the North-Eastern Power Company's system made it possible for the consulting engineers to install two main generating sets having a high efficiency combined with a low capital cost. A two-cylinder single-shaft turbine with a maximum continuous rating of 20,000 kilowatts met the requirements, but at the time the station was designed a single generator having an output of 20,000 kilowatts at .75 power factor could not be built for a speed of 2400 revolutions per minute. Consequently each of the two main sets was provided with two 10,000-kilowatt generators mechanically coupled in tandem and connected in parallel electrically with a single machine for providing the exciting current. In the event of a breakdown occurring on one of the generators the other machine can be operated alone. Moreover, a jack shaft is provided to take the place of one of the rotors if it should be necessary to remove a rotor for the purpose of repairs. With a slightly higher temperature rise than usual each generator will carry at unity power factor an economical load of 16,000 kilowatts, and in order to recover a portion of the generator losses the outgoing air used for ventilating the windings is supplied by forced draught fans to the boilers.

Partly on account of the fact that steam passing between the high and low-pressure cylinders is re-heated by leading it to re-heaters forming an integral part of some of the boiler units, the boiler-house is arranged parallel to the engine-room and the turbines are placed lengthways as shown on page 658.

There are ten boilers arranged in two rows, and the five boilers that back on to the engine-room are equipped with re-heaters, the result being that the pipe connections to the turbines are short. A specially designed relay operating a valve for by-passing steam from the re-heaters direct to the condensers prevents the accumulation of steam in the re-heater, which would cause the turbines to run away and trip out in the event of the load suddenly falling to zero.

In general the design of the boiler plant conforms with that of the usual Babcock marine boilers worked at low pressures, but the tubes have a much smaller outside diameter than usual. The drums are also small and they are made of thick plate. Moreover, the boiler fittings and steam and water pipe flanges and valves are, of course, designed to withstand the high pressure. The main troubles—in fact, it is said, the only troubles—that have arisen as the result of using steam at a pressure of 450 lb. per square inch at the turbine stop valves have been the liability of the gauge glasses to fracture and the cutting of the valve seats, but by the judicious choice of materials and fittings the difficulties are gradually being overcome. Simple tubular air heaters with spiral retarders inside the tubes are used for the purpose of assisting the transfer of heat and for enabling dry deposit of dust from the flue gases to be readily removed.

The auxiliaries are arranged on the well-known unit principle as first adopted at Carville in 1904, which was originally designed for ensuring a reliable auxiliary supply. The system has also proved advantageous from the thermodynamic point of view, as all the steam is used by the large and efficient generating sets. At the North Tees station the system has been extended by the installation of both motor-driven and steam turbine feed pumps, but the latter merely serve as a stand-by and under normal conditions the feed is provided by electrically driven pumps, which are supplied with current from the main generators. In stations in which the practice of bleeding the main turbines is adopted, electrically driven auxiliaries should obviously be used, because

exhaust steam from steam-driven auxiliaries is not needed for heating the feed water.

For the site works, foundations, screen pits, jetty, circulating water mains, discharge ducts and brickwork, Sir Robert McAlpine and Sons were the main contractors. Babcock and Wilcox, Limited, were responsible for the steel frame buildings, for the boiler-house and engine-room, including the roofs, floors, coal and ash soot bunkers and flues. They also supplied the boiler-house equipment, details of which are given in the following table :—

	With re-heater.	Without re-heater.
Type	Water tube marine steel cased.	
Number installed	5	5
Heating surface of boiler, square feet	6,756	6,980
Heating surface of superheater, square feet	3,050	3,050
Heating surface of re-heater, square feet	3,490	—
Heating surface of air heater, square feet	10,560	9,245
Grate area, square feet	196	168
Water economisers	None	None
Type of stoker	Travelling grate	
Normal working steam pressure at superheater outlet in lb. per square inch above atmosphere	—	475
Normal working steam temperature at superheater outlet, deg. Fah.	—	700
Normal evaporation per hour per boiler, lb.	—	42,000
Continuous overload capacity, per cent.	—	25
Air pressure in main air flue, inches of water	—	3½
Normal capacity of re-heater, lb. of steam per hour	—	75,000
Maximum capacity of re-heater, lb. of steam per hour	—	90,000
Pressure of steam to be re-heated, lb. per square inch above atmosphere	—	65
Entering temperature, deg. Fah.	—	350
Leaving temperature at normal output, deg. Fah.	—	520
Drop in pressure, lb. per square inch	—	¼
Outlet temperature flue gases from air heaters, deg. Fah.	—	300
Temperature of air entering stoker, deg. Fah.	—	350

The Sirocco fans for the forced and induced draught system were supplied by Davidson and Co., Limited, of Belfast. Each of the turbo-alternators was built by the Metropolitan-Vickers Electrical Company. The voltage of the machines is 11,500, the periodicity 40 cycles per second, and the speed 2400 revolutions per minute. Air for ventilating the alternators is supplied partly by fans on the rotors and partly by independently driven motor fans, and, as already stated, the heated air is supplied to the boilers. The air filters used for purifying the air were supplied by Heenan and Froude, Limited.

There is a single condenser, with a cooling surface of 25,000 square feet, for each of the two generating sets. The air pumps are of the Le Blanc rotary type, and each pump is directly coupled to a 400 brake horse-power motor, which also drives the alternator ventilating fans. Gwynnes, Limited, supplied the circulating water pumping plant, which consists of three pumps of the vertical centrifugal type. The capacity of each pump is 26,000 gallons per minute at a speed of 343 revolutions per minute, the head of water being 27ft. Each pump is driven by a 400 brake horse-power motor, supplied by the Metropolitan-Vickers Electrical Company. The circulating water screens, which were supplied by F. W. Brackett and Co., Ltd., are of the inclined endless belt system.

The boiler feed pumps were made by Mather and Platt, Limited, the switchgear by A. Reyrolle and Co., Limited, the engine-driven crane by Babcock and Wilcox, Limited, and the station transformers by Ferranti, Limited. All the station auxiliary motors, with the exception of the stoker motors, were supplied by the Metropolitan-Vickers Electrical Company. The stoker motors are of the Creedy three-phase multi-speed type, and were supplied by F. and A. Parkinson, Limited. The battery-charging motor generators were supplied by J. H. Holmes and Co., who also installed a direct-current lighting switchboard. Two battery locomotives, each weighing 27½ tons, are used in connection with the storage of coal and the disposal of ashes and for any other necessary work.

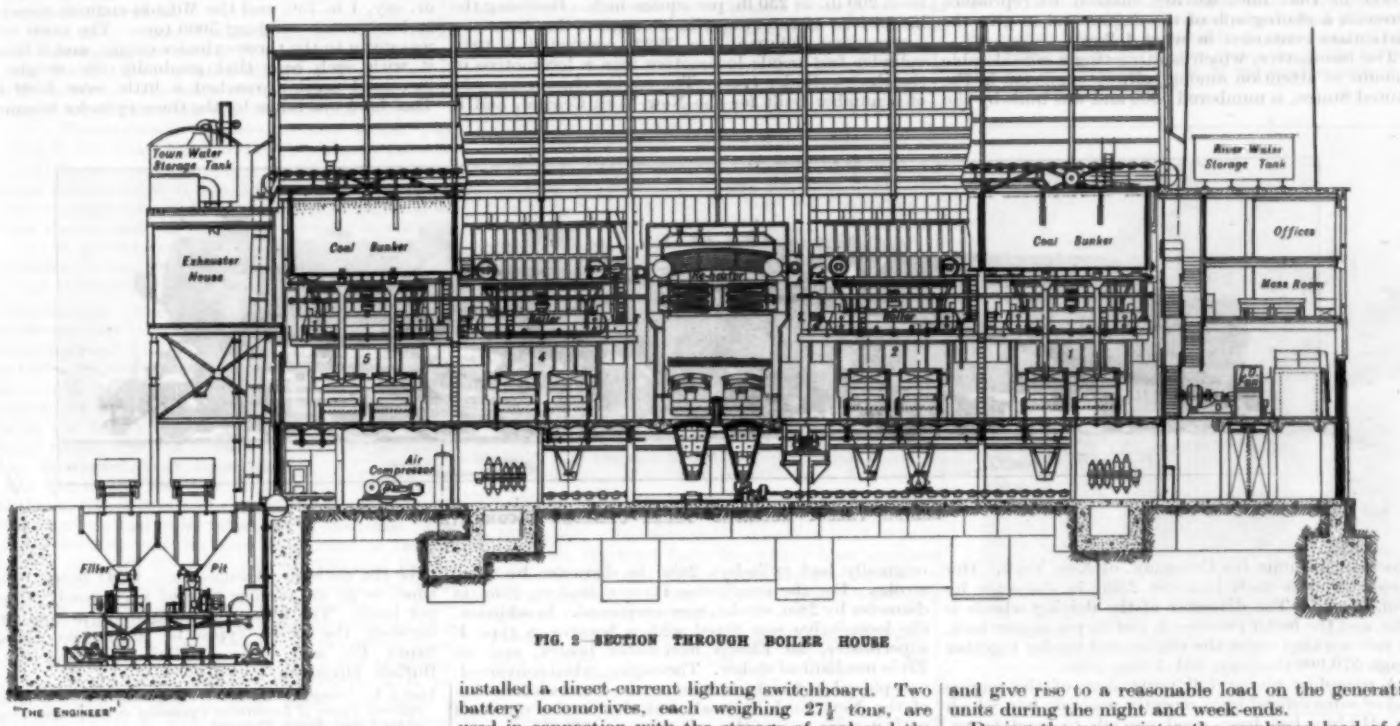


FIG. 2—SECTION THROUGH BOILER HOUSE

For the transmission of power, some twenty cables had to be laid across the river Tees, and a trench was dredged in the river bed. The work of laying these cables, it appears, was not an easy task, for the river is navigable, and is subjected to heavy tides, whilst the width at the point where the cables are laid is over 400ft. Moreover, in order to provide for future dredging to increase the depth of the navigable channel, the cables had to be laid exceptionally deep.

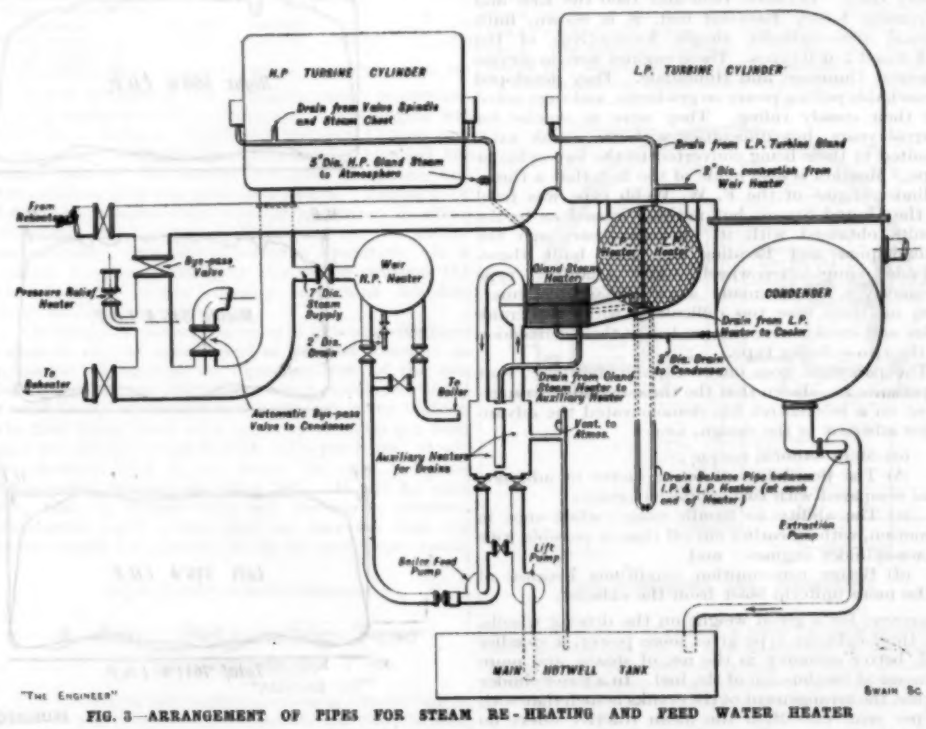


FIG. 3—ARRANGEMENT OF PIPES FOR STEAM RE-HEATING AND FEED WATER HEATER

This North Tees two-unit station was arranged so that it could eventually either be treated as an annexe to a larger station operating under the same conditions, or if, as the result of experience, modifications in the cycle were found to be desirable, it could be kept entirely separate from any new plant. Extensions to the station are, however, already being carried out, and it is expected that as soon as trade improves there will be a rapid increase in load. Owing very largely to the depression in the shipbuilding and iron and steel industries during the last few years, the new station is only just beginning to run under favourable conditions, and although it headed the list of stations of its class in the Electricity Commissioners' tables issued in 1923, with an average coal consumption of 1.73 lb. per kilowatt-hour generated during that year, it has not yet reached under long-period commercial service the expected weekly operating efficiency of 21 per cent. But tests that have been carried out on the plant have indicated that that efficiency will be secured when industrial conditions improve and give rise to a reasonable load on the generating units during the night and week-ends.

During the past winter the combined load of the North-Eastern Power Companies reached 165,000 kilowatts, 60,000 of which were dealt with by the Carville station, 51,000 kilowatts by the Dunston station, and 25,000 kilowatts by the new North Tees station, the remainder of the load being carried by the waste heat stations and other similar plants.

On the north bank of the Tees, where the station is situated, housing accommodation is scarce, and consequently the power company has built a model village at Billingham for the accommodation of the station's workpeople. The estate, which is about a mile distant from the station, has been laid out on garden city lines. There are seventy-three houses, the majority of which are semi-detached. The gardens and roads are laid out in an artistic manner and all the houses are equipped with electric light, electric heaters and cookers, and an electrically heated wash boiler. The living-room in each house is fitted with a single open fire-place, combined with a hot-water boiler, and there is a fire-place in the bedroom.

The consulting engineers for the North Tees station were Merz and McLellan, to whom we are indebted for the information embodied in this article.

American Three-cylinder Locomotives.

THERE has recently been put into service by the Lehigh Valley Railroad Company a three-cylinder locomotive of an interesting type. By the courtesy of Mr. F. N. Hibbits, the Superintendent of Motive Power of that line, we are enabled to reproduce herewith a photograph of the engine and to give the particulars contained in what follows.

The locomotive, which is attracting a considerable amount of attention among railway engineers in the United States, is numbered 5000 and was built by the American Locomotive Company, of New York. Her three cylinders each measure 25in. in diameter by 28in. stroke. The diameter of the driving wheels is 69in. and the boiler pressure is 200 lb. per square inch. In full working order the engine and tender together weigh 570,000 lb.—say, 254.5 long tons.

A pamphlet giving full particulars of the engine and of some official tests recently made on her, which Mr. Hibbits has been good enough to send to us, contains a good deal concerning the attitude of American locomotive engineers towards the three-cylinder engine, and we feel sure that the following *résumé* of it will be read with interest by other locomotive engineers.

It is explained at the outset that, while in the past the three-cylinder type of locomotive has received some attention from American designers, the complications of the valve gear and the traditional prejudice against the crank axle deterred them from making any serious attempt to develop such an engine for heavy duty. Between 1890 and 1900 the Erie and Wyoming Valley Railroad had, it is shown, built several three-cylinder simple locomotives of the 4–4–0 and 2–6–0 types. These engines were in service between Dunmore and Honesdale. They developed remarkable pulling power on gradients, and were noted for their steady riding. They were in service for several years, but difficulties with the crank axles resulted in their being converted to the two-cylinder type. Mention is also made of the fact that a three-cylinder engine of the F. W. Webb type was tried in the United States, but nothing is said as to the results obtained with it. Several years ago the Philadelphia and Reading line also built three-cylinder simple, ten-wheel, and "Atlantic" type locomotives, which made some remarkable runs; but, in their case too difficulties with the crank axles and inside valve motion led to their conversion to the two-cylinder type.

The pamphlet goes on to explain, however, that experience has shown that the three-cylinder arrangement on a locomotive has demonstrated the advantages inherent in the design, *i.e.*:—

(*a*) More uniform torque;
(*b*) The possibility of lower factor of adhesion as compared with two-cylinder engines;
(*c*) The ability to handle trains, when once in motion, with an earlier cut-off than is possible with two-cylinder engines; and
(*d*) Better consumption conditions because of the more uniform blast from the exhaust.

Moreover, for a given weight on the driving wheels, the three-cylinder type gives more power, a steadier pull, better economy in the use of steam, and more economical combustion of the fuel. In a two-cylinder engine, the arrangement of the cranks is such that with 85 per cent. cut-off, if the mean tractive effort be 40,000 lb., at one point in the revolution it will rise to as much as 50,000 lb., and unless there is sufficient weight on the drivers the engine will slip. In the case of the three-cylinder arrangement with the same cut-off and mean tractive effort, the increase will only be to 42,400 lb., and less adhesive weight is needed to prevent slipping than with the corresponding two-cylinder design.

The matter is summed up in the pamphlet as follows:—"It will thus be seen that with the three cylinders we may readily get a very high starting torque uniformly applied, thus reducing the stress on the draft gears, and also, that with the train once in motion, it may be hauled with a much shorter cut-off. Roughly, with a train loaded up to maximum starting capacity in each case, it may be hauled after starting at a 50 per cent. cut-off with a two-cylinder engine and at a 35 per cent. cut-off with a three-cylinder engine, thus promoting the economical use of steam."

Two-cylinder simple locomotives in the United States have now been built of a size in which piston thrusts are exceptionally high, cylinder diameters being as great as 31in. and boiler pressures running from 200 lb. to 250 lb. per square inch. Realising the limitations of the two-cylinder engine, the American Locomotive Company, in 1922, converted a two-cylinder fast goods locomotive into a locomotive of the three-cylinder type. The engine chosen was one of a number built for the New York Central, and it originally had cylinders 28in. in diameter by 28in. stroke. For the conversion three cylinders, 25in. in diameter by 28in. stroke, were employed. In addition, the locomotive was fitted with a booster, a type E superheater, an Elesco feed-water heater, and an Elvin mechanical stoker. The engine, when converted, was placed in freight service on the Mohawk Division of the New York Central, and the results obtained with it were eminently satisfactory. The increase in weight on the drivers, as compared with the two-cylinder engine, was very small, and the additional hauling capacity enabled it to deal with considerably heavier trains.

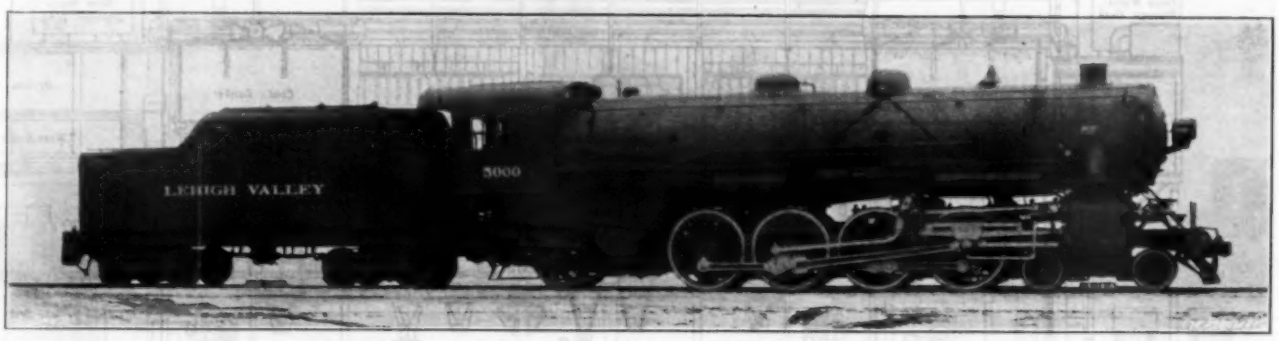
The satisfactory working out of this design led the builders to develop and build a complete new locomotive of the same type, and the engine evolved is that which is illustrated herewith. The wheel arrangement was kept the same as in the New York Central locomotive, and so were the size of the cylinders and the diameter of the driving wheels. The rigid wheel base is 18ft., the wheel base of the engine is 41ft. 2in., and that of the engine and tender together 77ft. 8in. A type A Schmidt superheater is used and a combustion chamber and Elvin stoker applied, but the main rods, instead of being all coupled to the second pair of driving wheels, were coupled inside to the second axle and outside to the third.

The engine was turned out of the Brooks Works of the builders in October, 1923. It was at first placed in service on the Buffalo Division of the Lehigh Valley system, and for several weeks was engaged in hauling heavy freight trains over that division. The locomotives previously used in the same service had been of the "Mikado" type with a tractive effort of about 63,000 lb. The three-cylinder engine has a tractive effort of 64,700 lb. The total weight on the four driving axles is 246,500 lb., the average per axle being therefore 61,625 lb., or just over 27.5 tons. The ruling gradient on the division is 21ft. to the mile, or, say, 1 in 250, and the Mikado engines were rated to haul trains weighing 3000 tons. The same weight was given to the three-cylinder engine, and it handled it with such ease that gradually the weight was increased until it reached a little over 4500 tons. That load was taken by the three-cylinder locomotive over the division 94 miles long, in 4½ hours running time, or at an average rate of very nearly 21 miles per hour. The following table shows a comparison between the three types of locomotive—Mikado, Santa Fé, and three-cylinder—operating on the Buffalo Division:—

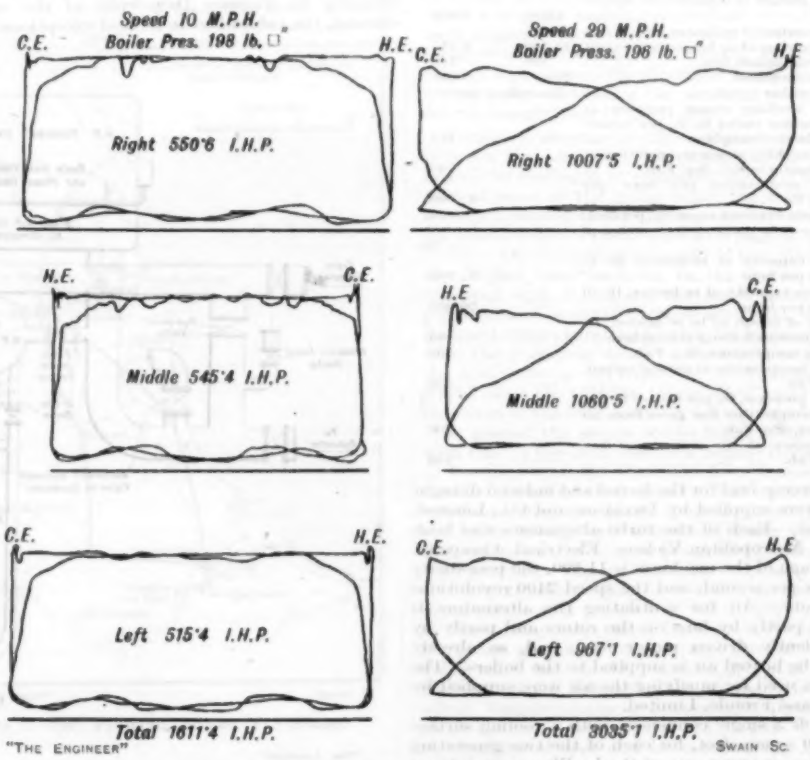
TABLE I.—*Comparison between Mikado, Santa Fé, and Three-cylinder Types of Locomotive Operating on the Buffalo Division of the Lehigh Valley Railroad.*

Tractive Effort and Load Hauled.

No. of cylinders.	Type of engine.	Booster.	Tractive effort.	Weight of train, tons.
2	2–8–2	None	59,000	3000
2	2–8–2	With	69,000	3500
2	2–8–2	None	63,000	3250
2	2–8–2	With	73,000	3750
2	2–10–2	None	72,600	3500
3	4–8–2	None	64,700	4500



LEHIGH VALLEY RAILROAD—THREE-CYLINDER LOCOMOTIVE



INDICATOR DIAGRAMS

Comparative Performances.

Type	2–8–2	2–10–2	4–8–2
Number of cylinders	3	2	3
Diam. and stroke, in.	27 × 32	29 × 32	25 × 28
Diam. of drivers, in.	63	63	69
Boiler pressure, lb.	200	200	200
Weight on drivers, lb.	235,500	289,000	246,500
Weight, total, lb.	318,000	370,000	369,000
Tractive effort, lb.	63,000	72,600	64,700
Load on train, tons	3,000	3,500	4,000
Running time, hours	5½	6	4½
Distance, miles	94	94	94
Time in minutes / Ton-miles	0.00117	0.00106	0.000718

This performance was so good that the railway company decided to carry out some exhaustive tests so

as to obtain accurate indicator readings and data regarding coal and water consumption, and entrusted the carrying out of the trials to Mr. W. I. Cantley

The locomotive was equipped for the purposes of the test at the East Buffalo shops, the following fittings being added to those already in place :—

(*a*) Gauge glasses applied to the corners of the tank to measure the water. The tank was calibrated by weighing out the contents in a barrel mounted on platform scales.

(*b*) A drop-bottom coal box applied to the tender for measuring the coal. The capacity of the box was checked by repeated fillings and weighing of the contents. The same grade of coal as was to be employed on the trials was used for this purpose.

(*c*) Thermometers applied to the steam pipe close to the steam chest and to the exhaust passage.

(*d*) Steam gauges applied to the saturated and superheated sides of the header, and a recording steam gauge connected to the boiler in such a position that it could be read from the indicator box.

(*e*) A speed recorder in the cab and a revolution counter for checking the speed.

(*f*) Indicators applied to all three cylinders.

Preliminary runs were made between Buffalo and Manchester from December 20th to 23rd last year, for the purpose of adjusting the instruments and drilling the staff who were to be in charge of the tests. The results achieved on this trip are not reported, since they "appeared entirely too good to be true," but on the 29th and 30th of the same month a successful round trip was made and upon it the figures given in what follows were based.

The test of the 29th was made from Tifft Farm to Caledonia, where it came to an end because a car with a hot axle-box had to be taken out of the train. The trial on the 30th was run from Manchester to Depew, 13 miles of which between milepost 425 and Depew is practically continuously downhill, and the total "drifting" time is given as being 32 minutes. From Tifft Farm to Caledonia the drifting or coasting time was only 17 minutes. The observed figures during these tests are grouped under no less than 158 headings, and as it would be manifestly impossible for us to reproduce them all here, it must suffice to make a selection, which is done in the table given below. Before proceeding to give the results of the tests, however, it would be well to give in Table II. some additional data concerning the locomotive.

TABLE II.—*Particulars of Locomotive* 5000.

Weight on drivers	246,500 lb.
Weight on bogie	66,000 lb.
Weight on trailing axle	56,500 lb.
Weight on engine	369,000 lb.
Weight on tender, loaded	201,000 lb.
Tractive effort	64,700 lb.
Factor of adhesion	3.81
Grate, length and width	126⅛in. by 96⅛in.
Grate area	84.3 square feet
Tubes, number and diameter	230—2¼in.
Flues	50—5½in.
Flues, length and spacing	21ft.—⅛in.
Combustion chamber, length	52in.
Heating surface, tubes	2832 square feet
Heating surface, flues	1505 square feet
Heating surface, fire-box and arch tubes	392 square feet
Heating surface, total	4729 square feet
Superheating surface	1249 square feet
Superheater, outside diameter of pipes	1½in.

The auxiliaries included a cross-compound Westinghouse air pump, an Elvin stoker, a B. and S. drifting valve, a headlight generator, injectors, and a superheater damper operated by superheated steam.

In Table III. is given a selection we have made from the figures included in the log of the tests.

TABLE III.—*Log of Tests.*

Date	29/12/23	30/12/23
From	Tifft Farm	Manchester
To	Caledonia	Depew.
Length of run, miles	59.4	77.4
Working distance, miles	56.4	62.4
Drifting distance, miles	3.0	15.0
Time working, minutes	172	190
Time drifting, minutes	17	32
Time running, minutes	189	222
Time delays, minutes	9	24
Time, start to stop, minutes	198	246
Number of stops	1	2
Weight of train behind engine, tons	4619	3929
Average speed while working, miles per hour	19.68	19.70
Maximum speed shown by cards, miles per hour	40	46
Average temperature of steam in branch pipe, deg. Fah.	615.5	623
Average temperature of steam in exhaust pipe, deg. Fah.	334.7	310.7
Average boiler pressure	185.6	194.1
Coal	Bituminous,	Run of mine
Coal, moisture, approx., per cent.	3.02	2.49
Coal, calorific value, B.Th.U. per pound	12,600	12,712
Water apparently evaporated per pound of fuel as fired, lb.	7.288	7.658
Water per I.H.P., including auxiliaries, lb.	21.09	19.63
Coal as fired per hour working time, lb.	6310	5713
Coal as fired per square foot of grate per hour, lb.	74.85	67.77
Coal as fired per I.H.P. hour, including auxiliaries, lb.	2.89	2.56
Coal as fired per I.H.P. hour less auxiliaries, lb.	2.81	2.47
Efficiency, boiler only, based on fuel, per cent.	68.81	71.73
Efficiency, boiler and superheater, per cent.	76.17	79.56
Average I.H.P. of locomotive	2180	2228
Maximum I.H.P. of locomotive	3035	2896
at a speed of, miles per hour	29	46

As has been mentioned, the trip on December 30th included the long "drift" of 13 miles. No deductions from the fuel and water consumed were made for this drift, all the fuel and water from Manchester to Depew being credited to the actual working time of the engine, or to the time the regulator was open. In calculating the average horse-power indicator cards taken at five minutes' intervals were employed. In his report on the trials Mr. Cantley draws particular attention to the coal per indicated horse-power hour which was consumed during the trial on December 30th when the average cut-off was about 53 per cent. The total consumption was about 2.56 lb. and no deduction was made for the coal used to operate the stoker and brake pump, nor for loss of steam through the safety valves.

After the tests were completed the locomotive was transferred to the Seneca Division East and the Wyoming Division, operating between Sayre and Lehighton, a distance of 145 miles, *viâ* the mountain cut-off. The ruling gradient eastward is 61½ft. to the mile, or 1 in 86.2, and westward a maximum of about 69ft. per mile, or, say, 1 in 76.5. The purpose of the transfer was to ascertain if the engine could satisfactorily handle milk trains weighing approximately 1200 tons, which had previously required "Pacific" type locomotives double-headed. The combined tractive effort of the two engines going east was approximately 90,000 lb., and going west approximately 97,000 lb. Engine 5000 was given a trial trip with a train weighing a little over 1300 tons. It had no difficulty in hauling the train over the mountain by itself and keeping schedule time. Since that trip it has been regularly used in milk train service and has had no help over the incline at any time, though occasionally the weight of the train has been as much as 1550 tons. In this service speeds of over 60 miles an hour on the level have frequently been attained.

In Tables IV. and V. are given the performance of the new engine and of the "Pacific" engines formerly employed to work the train.

TABLE IV.—*Comparison of Engines Working the Milk Train.*

Class of engine	K2½	K5½	81
Number of cylinders	2	2	3
Diameter and stroke, in.	25 × 28	27 × 28	25 × 28
Diameter of driving wheels, in.	77	73	69
Boiler pressure, lb.	215	205	200
Weight on drivers, lb.	161,940	204,560	246,500
Weight, total, lb.	262,160	311,000	369,000
Tractive effort, lb.	41,500	48,700	64,700

TABLE V.—*Comparison of the Operation of the Milk Train.*

Direction	East	West	East	West
Ruling gradient, feet per mile	61½	69	61½	69
Average cars on train	191'ded, 1 van	38 e'pty, 2 vans	191'ded, 1 van	38 e'ty 2 vans
Leading engine, class	K5½	K5½	81	81
Leading engine, tractive force	48,720	48,720	64,700	64,700
Helper engine, class	K2½	K5½	None	None
Helper engine, tractive force	41,530	48,720	—	—
Total tractive power	90,250	97,440	64,700	64,700
Total weight of engines and tenders	574,000	623,800	570,000	570,000

It will be noticed that formerly, when eastbound, a K5½ engine was in the lead and a K2½ engine was used as a helper. That was between Coxton and Gracedale. Westbound a K5½ engine handled the train, but on the incline between Lehighton and Gracedale a K5½ was used as a helper. Engine 5000 handled the same train without assistance in either direction, but dropped a little time on the incline as compared with the two-engine operation. It is stated, however, that over the whole division the three-cylinder engine usually maintains schedule time without any difficulty.

The pamphlet includes a series of indicator diagrams taken at various speeds and at various powers. As a matter of interest we reproduce two of the sets herewith. In one the power being developed is the lowest in the series and in the other it is the highest, the first being taken at a speed of 10 miles per hour and the other at a speed of 29 miles per hour. It will be observed that in the latter the total indicated horse-power was no less than 3035. It will be seen, too, that in neither case are the three cylinders developing equal power, and we may say that the same remark is applicable to all the cards reproduced.

A New Detachable Tube Superheater.

THE detachable tube superheater was one of the earliest forms of superheater to be designed, but when in later years further developments took place, it became almost entirely superseded by the expanded tube superheater familiar to modern users. This change was caused, no doubt, by a sound desire to eliminate as far as possible any leak which might take place when a multiplicity of screwed or bolted joints was used.

For ordinary boiler conditions there is no difficulty in meeting all the normal requirements of a good superheater with tubes expanded into the headers, and for uniform working, such a design is perhaps preferable, but if working conditions are to some extent unknown, and it may prove convenient to add to or to diminish the heating surface of the superheater by increasing or decreasing the number of tubes, then the detachable tube type of superheater clearly possesses considerable advantages over the expanded tube type.

We recently had the opportunity of examining the designs and constructional details of an improved form o detachable tube superheater, which has been evolved by Mr. Thos. Sugden, of T. Sugden, Limited, a firm which possesses wide experience on this particular class of work extending over many years.

The new superheater has been standardised in various sizes, and it possesses some interesting features. The general arrangement of such a superheater when fitted to the back of a Lancashire boiler is shown by the diagrammatic illustration we reproduce in Fig. 1. The main feature is that each superheater tube is separately connected to the header by means of atwo-bolted joint, which, the makers claim, is preferable to any form of jointed connection where one or two joints are made by means of a single bolt. The whole of the header range is pro

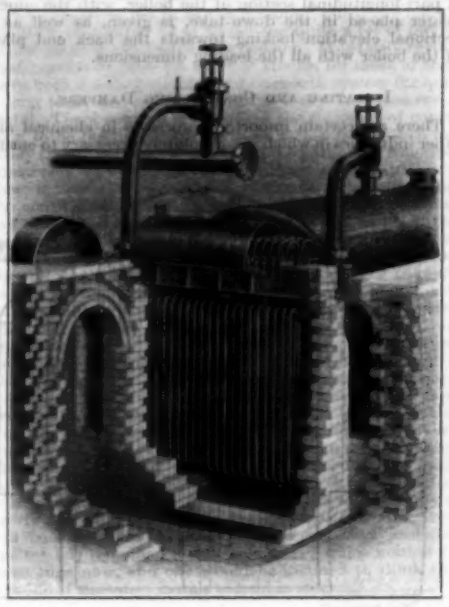


FIG. 1—SUGDEN DETACHABLE SUPERHEATER

tected by light steel covers, which are easily removable, and give access to any part of the superheater.

We show in Fig. 2 a sectional drawing of the header and tube connections. It will be seen that each tube is secured to its header by two steel grip bolts, which are designed of ample strength and are easily removed and replaced. The actual joint between the tube and the header is made by accurately facing the surface of the header and the face of the collar, which is expanded on to the end of the tube. A thin washer of jointing material is interposed between these two faces, and the joint is closed by screwing down the two spherically seated cap nuts on to the steel bridge piece. The machined seatings of the cap nuts and bridge pieces give automatic and quick alignment; further, if by chance one bolt should in any way fail, the tube will not

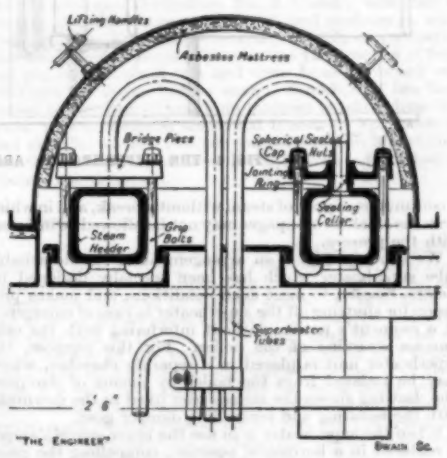


FIG. 2—HEADERS AND CONNECTIONS

blow out, since it is carried a short distance beyond its seating collar and will be held in position by the slightly canted bridge piece secured by one bolt only. It may be noted that the new design does away with all studs and set screws, and the troublesome work of drilling out and removing broken or heat-corroded screws or studs is thereby entirely eliminated.

With the design illustrated it also becomes unnecessary to tie the two steam headers together, and each are left free to respond to the expansion and contraction of the steam pipe connections.

Another advantage is the ease with which such a superheater can be erected. The fixing of the tubes to the header is a very simple matter, as each tube end-centres itself and is held in position by its own weight, no packing strips or other form of support being necessary to keep the tubes in position while the actual joint is being made. All the parts are made to standard and are completely interchangeable.

As the joint is on the top of the header, it is accessible and readily visible, so that the condition of each individual joint can be inspected at all times. A series of light semi-circular steel covers, furnished with lifting handles, are

provided, which are on the underside furnished with an asbestos mattress, so as to prevent radiation and the admission of cold air into the superheater chamber.

Superheaters of this type are constructed to work at boiler pressures up to 300 lb. per square inch, and in practice the joints have been found, the makers inform us, to be so perfect that they can be rendered almost steam-tight when the nuts are only screwed down by hand. Very little extra pressure with a spanner is therefore necessary to make a sound and tight steam joint. Before leaving the factory each superheater is tested hydraulically to double or treble its normal working pressure.

The drawing reproduced in Fig. 3 shows the detachable tube superheater fitted to a 30ft. long by 8ft. diameter Lancashire boiler, designed for a working steam pressure of 200 lb. per square inch, and for adding from 150 deg. to 200 deg. Fah. superheat to the steam at full load duty. A part-longitudinal section of the boiler, with the superheater placed in the down-take, is given, as well as a sectional elevation looking towards the back end plate of the boiler with all the leading dimensions.

ISOLATING AND CONTROLLING DAMPERS.

There are certain important processes in chemical and other industries in which it is absolutely necessary to ensure a continuous supply of steam without a break, and in which even the smallest stoppages may not be allowed to interfere with the process.

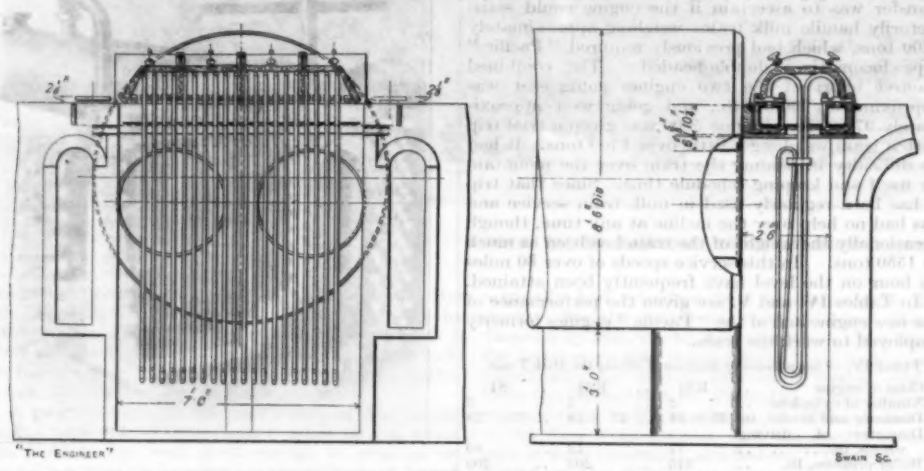


FIG. 3—SUGDEN DETACHABLE SUPERHEATER FITTED TO LANCASHIRE BOILER

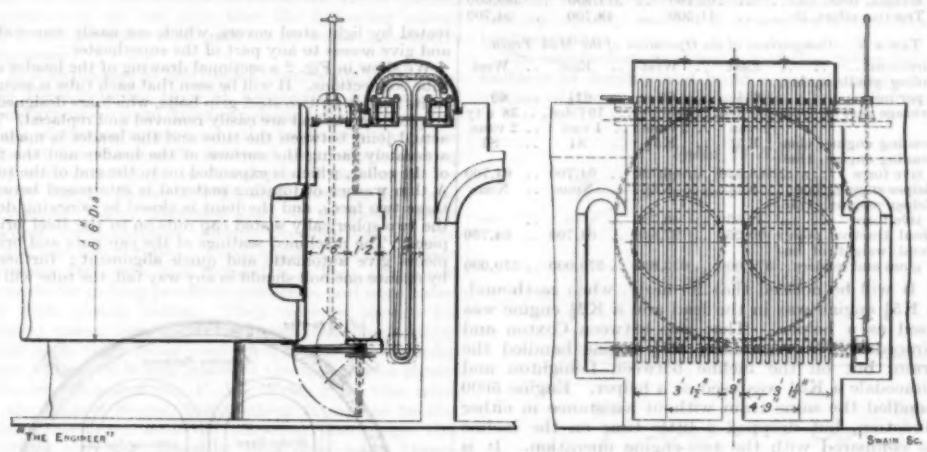


FIG. 4—THE SUPERHEATER ARRANGED IN AN ISOLATING CHAMBER

We show in Fig. 4 an arrangement of the detachable tube superheater which has been specially designed by Messrs. Sugden to meet such conditions, and makes provision for shutting off the superheater in case of emergency at a moment's notice, without interfering with the continuous steaming of the boiler. For this purpose, the superheater unit is placed in a separate chamber, which may be isolated from the boiler by means of dampers. The drawing shows the superheater fixed in the downtake with the isolating and controlling damper gear.

When the superheater is in use the lower swivel damper is replaced in a horizontal position, compelling the gases from the boiler to pass into the superheater chamber, which is formed by a division wall built into the boiler downtake. If the swivel damper be lowered to the vertical position indicated by the dotted lines, the hot gases are by-passed and by inserting small sectional slab dampers, which rest on the division wall, the superheater is completely isolated. The sectional slab dampers referred to are only used in case of emergency, and when the swivel damper is in the bottom vertical position and the slab dampers inserted, the boiler continues working at full load without any steam passing through the superheater, for the latter is entirely protected from injury, as the furnace gases pass directly into the bottom flue of the boiler without entering the superheater chamber.

On the other hand, the swivel damper can well be used to control the quantity of the gases which pass into the superheater chamber, and hence the degree of superheat imparted to the steam. Such dampers form a most convenient means of regulating the temperature of the superheated steam, and are used extensively for this purpose. The superheater arrangement which is described in the foregoing is made by T. Sugden, Limited, of 180, Fleet-street, London, E.C.

Oil Engine Operation for Dredgers and Excavating Machinery.

A FEATURE in the development of modern excavating machinery in America is the extending use of the oil engine in replacing the formerly universal steam engine, and at the recent convention of the American Land Drainage Association, this subject was discussed by Mr. Geo. B. Massey, consulting engineer, in a paper from which the following information is compiled. It may be noted also that among American excavating machines of this class is a large Diesel electric ladder dredger at work on the Ohio River.

Reduction in cost of operation in excavating machinery lies largely in the item of fuel, and Mr. Massey points out that it is in that direction that the oil engine has its main advantages. A pound of fuel oil as used in internal-combustion engines has about 18,500 to 19,000 B.Th.U., while a pound of good coal has 12,500 to 13,000 B.Th.U. The hot bulb engine has an overall thermal efficiency of about 25 per cent. On an excavating machine this efficiency is about 50 per cent. for the average hand-fired boiler, and 5 per cent. for the quarter crank engine, or a combined thermal efficiency of 2½ per cent.—one-tenth that of the oil engine. Thus ½ lb. of oil in a hot bulb engine will develop the same power as 10 lb. of coal or 5 lb. of oil in a portable steam boiler. For transportation, the weight is as 1 for oil to 20 for coal; while for storage, the relation is as 1 to 22. In cost, with oil at 2½d. per gallon and coal at £1 per ton, the relation is as 1 to 7. In addition, there is a considerable saving in the cost and loss in handling fuel. With the steam boiler there are delays due to cleaning fires and tubes, low steam pressure, &c., while fires have to be banked. With the oil engine there should be no delays in the working shift, and if carbon collects in cylinder heads or exhaust passages it can be removed when other light repairs are made at intervals of a week or more.

Oil-engine installations on excavating machines include several different arrangements. First, driving an air-compressor to supply air for operating the hoisting and slewing engines. Second, driving the hoisting equipment by belt and driving a compressor to operate the slewing engines. Third, driving all equipment by belts, with clutches for the slewing gear. Fourth, driving electric generators to supply current for motors operating all the equipment. With the straight oil engine drive, as applied to machines formerly operated by steam, the oil engine operates the entire equipment by a belt or rope drive. A friction clutch is applied to the driving or driven pulley to transmit power to the shafting and gears. The hoisting, backing or drag-line drums are driven through air-operated friction clutches, while the slewing is effected by two friction clutches of the multiple-disc type.

Where several excavating machines are used on one piece of work, they may be equipped with electric motors and current supplied from a central generating station operated by oil engines. The advantages of oil are less in this case, the relation of oil in an oil engine to fuel oil in a stationary steam plant being as 1 to 2. Large oil engines are usually of the full Diesel type.

The modern oil engine makes it practicable to provide a self-contained electrically-driven excavator, having advantages of movement and independence of power supply which are not usually associated with electric machines. The advantages of electric drive for the various motions are in power, speed, smoothness of operation and ease of control. The advantages of the oil-engine generator unit are in economy, simplicity, ruggedness and reliability.

Automatic control equipment of the rheostatic type has been used generally on excavating machines, but the Ward-Leonard system, which utilizes the principle of controlling the generator voltage to secure smooth starting and speed regulation on the motors, has recently been adapted to the work. With it there is increased ease of control, simplicity, reliability and smoothness of operation. With it, too, individual motor drive is provided for each separate motion, thus giving maximum efficiency of power transmission. The starting, stopping and reversing of the several motions are controlled by means of a simple master switch or controller. Each motor gets its current from an individual generator. This arrangement, in combination with the control, gives for each motion a complete and independent electrical system, including generation, transmission and application. By varying the generator voltage over a wide range any required motor speed can be obtained, without rheostatic losses in the line circuit.

A differentially-wound series field on the generator automatically reduces the voltage as the torque required of the motor is increased. This result is a speed torque characteristic which is very advantageous for excavating operations, and greatly reduces the stresses and strains on the machinery. The power peaks on the generator will be kept at a minimum, owing to the fact that the generator voltage—which varies directly with the motor speed—is low when the current is high, the current varying directly with the motor torque. As the speed of hoisting the dipper or bucket will be high at light loads and low when heavy digging is encountered, so the voltage generated at the brushes will be high when the current is light and low when heavy torque requires heavy current. In this way the power peaks will be about two-thirds of what they would be with the ordinary constant voltage system. As a result, a much smaller engine may be used, since an oil engine must have a rating nearly as large as the maximum peaks to be encountered.

The various generators are assembled on a common bed-plate and connected to the engine by flexible couplings. With the low speed of most oil engines the design of these generators is comparatively simple, as there is plenty of space for the special field windings, but the size of machine required for the low speed makes the engine rather expensive. For drag-line excavators and similar machines subjected to violent and repeated changes in level, thrust bearings are provided which will eliminate end play and allow the generating set to operate at angles up to 18 deg. For dipper dredgers, of the steam navvy type, which are comparatively stable, this feature may be omitted.

The motors are of the mill type, of heavy two-bearing construction, suitable for gear drive. They are usually series wound to give flexibility and high starting torque. The determining factor as to the size of motor to be used is usually the maximum torque for the motion under consideration. It is desirable, of course, to keep the size down in order to reduce both the inertia and the cost.

For a large drag-line excavator the typical equipment includes a generator and motor for the hoist and drag-line drums, and another generator and motor for slewing. The two generators and an exciter are assembled on a heavy base and driven directly from the engine through flexible couplings. To supply power for the auxiliaries usually employed on a dredger, it is advisable to add a third generator of the constant voltage type. This can take the place of the direct-connected exciter, having sufficient capacity to supply power for pumps, hoists, &c., as well as excitation for the generators and control equipment.

A dredger or drag-line excavator is suitable for the installation of oil engines, and with the characteristics provided by the electric drive it is possible not only to cut down the peaks but also to run much closer to maximum capacity throughout the cycle. The action of the generators and motors is to provide a cushioning effect between the power source and the load without appreciable decrease in efficiency at extreme or intermediate points on the cycle.

The duty cycle on which this type of machinery operates is very indefinite, varying continually and over wide ranges. The series motors operated from generators of varying voltage are able to meet these conditions. Not only are the proper ratios of power and speed easily provided, but they are constantly changed and adjusted automatically to obtain maximum efficiency and speed of digging and movement. At the same time, the operator has complete control through the period of digging, and by means of the master switch he can reduce the speed or power or bring the equipment to a stop. Since the various motions are started and stopped from one to ten times a minute, the ability to accelerate and declerate rapidly is of prime importance. For this service the mill-type motors excel, being designed especially with low inertia for fast reversing.

Most of the oil engines for excavating machinery are of the hot-bulb type, two-cycle, multiple cylinder and vertical, depending on crank case compression for scavenging. In the smaller sizes there are horizontal engines which obtain a higher scavenging pressure by a crosshead construction and cylinder extension. There are also four-cycle engines. The hot-bulb engines should run at constant speed, and are not adapted to severe or prolonged changes in speed. The engines which depend upon compression for ignition are much more flexible in this respect, and the four-cycle full-Diesel engine can be run at almost desired speed indefinitely. The hot-bulb engines use gas, oil or distillates of 30 deg. to 40 deg. Beaumé; the full Diesel engines use fuel oil or gas oil of 24 to 26 Beaumé.

There is no question of the practicability of applying the oil engine to excavating machines and thus obtaining almost central station efficiency, and with an efficiency ten times as great as that of the ordinary steam plant on such machines. There is no question that either a friction drive or electric drive will give satisfactory service. Nor is there any question that the oil engine will reduce the fuel-handling charges and thus reduce the pay roll.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Whitsuntide Holidays.

NEARLY all the works in the Midlands and Staffordshire have been idle during the whole of this week, but some of the motor engineering establishments resumed work on Wednesday and others on Thursday. The Whitsuntide vacation is a favourite one in many establishments, because of the long days, for overhauling plants and carrying out repairs. Production has been suspended during the week, and many manufacturing firms were glad to shut down and accumulate new work, if possible. The market at Birmingham to-day—Thursday—was but thinly attended and business was meagre. The approach of the end of the quarter is partly accountable for the indisposition to place new contracts. Moreover seasonal slackness is beginning to overtake some of the industries in the district. General engineering is moving slowly, but in a few of the metal working branches of the Birmingham area, steady activity is reported. Trade is still very streaky, however. Consumers of iron and steel to-day took some interest in the slightly lower prices quoted for raw, semi-finished, and finished material, but their requirements were very small. There has been a considerable curtailment of output in the Midland coalfields. Some pits at which work has been proceeding without cessation for two years have now been put on short time.

Finished Iron.

The situation in the Staffordshire finished iron trade remains unchanged. The mills are still badly wanting orders, and many continue practically without employment. The trade still relies upon the insistence by many classes of buyers upon Staffordshire iron on account of its special fibrous quality, and marked bars continue popular for engineering and certain classes of railway requirements. Best bars are selling steadily at £15, and a certain amount of business is passing in Crown bars at £13. For attractive orders that price is shaded to the extent of half-a-crown. There is only a very poor demand for nut and bolt bars, but with an addition of 2½ per cent. to the labour costs mill owners say they cannot afford to entertain less than the £12 lately ruling. Belgian shippers are quoting £8 10s. to £8 12s. 6d. Steel, however, is being increasingly used for nut and bolt making, chiefly for users, especially railways, who insist on a high range of tensile tests with which neither English nor Belgian iron can comply. The price of steel is very nearly equal to that of Staffordshire iron. The local mills are chiefly engaged in the re-rolling of steel, in the absence of adequate business for wrought iron. Fortunately for the trade mills are readily adapted to the re-rolling of steel, and work of this class is being turned out for tube works, nut and bolt making, &c. Some falling off in the activity of the tube trade has reduced the call for iron and steel strip, which for some months was a most useful line for local mills.

The Rise in Galvanised Sheets.

After the recent quiet period, a strong demand for galvanised sheets has now appeared. Good lines have been placed by India, South America, and South Africa. Some of the bookings are sufficiently heavy to insure activity through the summer. As a result prices have further appreciated, and another rise of 10s. per ton has taken the price to £17 15s. for 24-gauge corrugated. Some district mills quote £18 and over. This is equivalent to an advance of fully £1 per ton on the quotations of a few weeks ago. The reduced requirements of the motor trade are being reflected in smaller orders for black sheets, and some mills in South Staffordshire have been laid idle.

Tin-plates.

The reduction in the basic price of tin-plates from 23s. 6d. to 22s. 7½d. has taken the market by surprise, business in this district having shown a slight improvement lately. It is probably a question of international competition that has dictated the manufacturers' policy. Tin-plate bars have been reduced 6s. 3d. per ton.

Pig Iron.

Though blast-furnacemen are finding demand extremely quiet they, for the most part, are holding on to their places in the expectation that coke will be available next month at less than 24s. at ovens, the present contract price. Odd lots can now be bought on the open market at lower rates. Meanwhile one of the Spring Vale furnaces has been withdrawn from production, and smelters will curtail output in other directions rather than accept the risk of stocking in face of the present uncertain poise of the market. In some quarters Derbyshire and Northamptonshire brands of No. 3 foundry pig iron can all be shaded but users show no disposition to cover forward requirements. Forge pig iron is not much called for in the present almost stagnant state of the Staffordshire iron trade, and prices in this department are purely nominal. The general quotations on 'Change in Birmingham to-day were—North Staffordshire No. 3 foundry, £4 15s.; forge, £4 7s. 6d.; Northamptonshire foundry, £4 11s.; forge, £4 5s.; Derbyshire foundry, £4 14s.; forge, £4 7s. 6d.; per ton at furnaces.

Furnace Damped Down.

The business in hand and in immediate prospect being insufficient to justify the continuance in operation of the present number of furnaces, Alfred Hickman, Limited, of Spring Vale Furnaces, Bilston, South Staffordshire, have been compelled to damp down another of their furnaces. There are now three, instead of four, out of five furnaces at this works in active commission, and until the orders come in with greater freedom the position will remain so. The slackness in the steel trade has lasted for some weeks.

Fuel Values.

Smelters are pressing for cheaper coke, which they consider the key to the pig iron situation. Coke makers, who lately demanded a rise on the 24s. figure at the ovens, now find it impossible to maintain this standard, sales having been made at 23s.; some users claim to have bought as low as 22s. They are still pressing for lower prices and are hopeful of a further reduction. They name 21s. as a fair market figure, though it is doubtful if this price will be reached for a time. Coke makers point to the abnormal price of small fuel as making it impossible to meet users' ideas in the matter of furnace coke prices.

Less Work on Cannock Chase.

The whole of the Cannock Chase collieries have closed down for three days for Whitsuntide. At present depression in the coal trade in that district is more acute than usual at this time of the year, and, on an average, only half-time has been worked at any of the pits during the past month. During the last week some 3000 miners "signed on" at the Employment Exchange at Cannock. The majority of them are employed at the West Cannock collieries, but more than 100 are engaged at the Coppice, Heath Hayes.

Steel.

Constructional engineers' demands for steel keep up fairly well and builders of rolling stock who are well supplied with orders are at the moment very useful customers. There is quite a good demand for joists, angles, and other rolled steel. Instability is still evident in steel bars. They are quoted at £10 upwards, but lower offers have been accepted in some cases. Steel strip is obtainable at £10 5s. to £10 10s. Continental steel mills are keener to get orders, but unsatisfactory deliveries against old engagements are against them. Belgian competition in steel bars is not very formidable, though consignments are offered at £8 for delivery in six weeks hence. Some good orders for ship-plates are expected to be placed by the Admiralty shortly in connection with the cruiser contracts. In the semi-finished department there are widespread complaints of underselling. Native billets have weakened after maintaining the £8 figure for some months, being now quoted £7 15s. per ton. Users claim to be able to buy at even lower figures. Belgian competitors are offering billets at £6 15s. to £7, a reduction of 5s. to 10s. per ton. Germany is offering billets on about as favourable a basis as Belgium, and is specialising on cold rolled thin steel strip, rather substantial sales having been made for various motor building requirements. Some large quantities of this re-rolling steel are appearing in the Black Country. These late arrivals are an embarrassment alike to customers and merchants, some of whom have had to replace the foreign material with English steel during the period of delay. There are still some arrears of Belgian orders to be cleared, and yards and sidings of Black Country iron and steel works show somewhat heavy stocks. The large steel orders are practically exhausted and are not being replaced. The mills are engaged in clearing up small tonnages, some of which have been on order for a considerable time.

Steel Scrap.

Steel scrap sells slowly and at the prices offered merchants are disposed to retain their material for a more favourable market. Sales are being affected at £3 18s. per ton delivered.

Unemployment Decreasing.

The latest returns show that there has been a further substantial decrease in the number of unemployed persons in the Midlands. The number out of work for the week ended June 2nd was 118,255 being a decrease of 1997 as compared with the previous week, and 422 as compared with the week ended May 19th. Unemployment was distributed as follows:—Men, 85,322; boys, 1893; women, 28,011; girls, 3029. The returns for the principal towns are as follows:—Birmingham area, 30,681; Bilston, 2576; Coventry, 2312; Cradley Heath, 4266; Dudley, 3826; Smethwick, 4105; Stourbridge and Brierley Hill, 3218; Tipton, 2240; Walsall, 5163; West Bromwich, 2893; Wolverhampton, 5853; Worcester, 1570.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE great Manchester holiday of Whitsuntide arrives at a time when neither buyers nor sellers of iron and metal are anxious to enter into any fresh transactions, and as a result the stoppage of business here will probably be prolonged beyond the usual period. There was a small meeting of the trade on the Manchester Exchange on Tuesday, but practically nothing was done. There seems to be great uncertainty here as to whether the markets, when they reopen next week, will be better or worse than they are now or rather than they were last week, for one cannot say that there is any market now. Some people take a favourable view on the ground that a certain accumulation of orders must occur, and if these are placed then a fillip will be given to trade for a time. One fears, however, that this accumulation will be less than usual, and that sellers will be too anxious to secure their share of it to have much disposition to put up prices, at any rate in the pig iron and steel sections of the trade.

Metals.

The uncertainty as to the prospects of the non-ferrous metals is greater than in the case of iron and steel, but we seem now to have passed through the extreme depression which was caused by the liquidation of the continental holdings. Standard copper, which at one time threatened to fall below £60 per ton, has got farther away from that figure, and although there is not likely to be any great consuming demand here for some time, yet on the whole the position of the consuming trades in Lancashire is rather better than it was. If once the conviction that we have passed the stage of lowest prices takes any general hold in the mind of the trade it is quite possible to have a spurt of buying. Of course, it is well known that consumers will never buy freely until the upward movement in prices has made some progress. In other words, consumers never get in at the bottom; but if the market should gain another £2 or £3 per ton quite a lot of buying might occur in the Lancashire district. It is fairly certain that consumers here are short of stocks, for most of them have been working on the hand-to-mouth system for quite a long time, and hence cannot have any large reserve of metal. There seems a chance that the statistics of copper soon to be published will again be rather favourable, and lately there has been a tendency on the part of the American consumers to buy more freely, perhaps in anticipation of these figures. On the other hand, it must be admitted that the continental position is still very bad. Optimists may say that it is so bad that it cannot be worse, and that this fact ought to be considered as a "bull point" for copper. Any change, they say, must necessarily be for the better. On the whole one may be justified in thinking that the buying of refined ingot at present prices is more likely to be wise than otherwise. The market for tin has made a very considerable recovery, and the consumer is now regretting that he did not secure his stock of metal three weeks ago. The belief that tin was on the way back to £150 per ton seems to have died out, and most people now speak well of the chances of the market. It is, however, extremely uncertain, but there is a chance that America will again be in the market to buy for July delivery, and this may give the fillip for which the market is waiting. The squeeze in prompt lead has now forced up the prices rather dangerously, and a "backwardation" of £3 per ton is an alarming feature. English lead was sold recently at nearly £3 per ton above the price of spelter. That there will be a collapse in these prices seems very probable. Spelter has remained a dull and rather quiet market for some time now, and one would be inclined to think that it is one of the safest metals to hold in stock.

Pig Iron.

The markets here for foundry iron are, of course, quiescent this week, and very little attempt is being made to do business. Many consumers are closed all the week, and in any case users of foundry iron are very unwilling to buy for forward delivery until they have a clearer idea as to which way the Cleveland iron market is going. That this class of iron can now be delivered in Manchester at 102s. 6d. per ton, in spite of the heavy carriage, indicates that Cleveland is again beginning to take her former place as the cheapest pig iron centre in the country. The question for the ironfounder here is whether he will soon be able to buy Cleveland foundry iron on better terms than the Midland irons. For about eight years this has not been the case. Derbyshire makers say that their prices cannot be reduced any more until costs are lower, and both in Scotland and in the Midlands there is talk of blowing out furnaces rather than submitting to further reduction. At the moment Derbyshire No. 3 foundry iron can be bought delivered here at 101s. 6d. and perhaps in some cases at 101s. One cannot form any opinion of the market this week, but it seems probable that the practice of buying pig iron in small lots and from hand to mouth will continue for some time to come. Scotch iron has been rather easier, and although no business is being done this week, it is understood that good brands of No. 3 can be had at 113s. 6d. to 114s. per ton delivered in Manchester and the district. East Coast hematite iron is to be had at about 110s. delivered.

Steel.

The depression in the manufactured steel market shows no sign of lifting. There has been very keen competition for any small orders for sections and plates, and sellers seem inclined to cut the prices. It is difficult to say at what lowest price business could now be done, but it is clear that £9 10s. per ton in Manchester is now the top price instead of the bottom price for joists and angles, and £10 2s. 6d. for flat bars and common plates. For these there is a very poor demand, but for boiler plate quality the demand seems to have been a little better. Foreign sections are offered here at 20s. to 25s. per ton below the price of British material. Foreign soft rolling billets were mentioned here at £6 12s. 6d. per ton.

Scrap.

There is very little definite change to note in the markets for old iron and steel material. The demand for melting steel scrap seems to have fallen off again, and it has been very intermittent for some time. Heavy wrought scrap is at about 100s. to 102s. 6d. delivered. Cast scrap for the foundries is nominally at 90s. to 92s. 6d. for good machinery metal, but no business is reported here.

Manchester Electricity Supply.

The abstract of accounts of the Manchester Corporation Electricity Department for the year ended March 31st last—some details of which I furnished in THE ENGINEER for May 9th last—shows that the average price of fuel for the year fell by 4s. 7d. and the total consumption amounted to 268,343 tons. The total sales of current were approximately 222 million kilowatt-hours, and the average price per kilowatt-hour was 1.57d. With regard to the progress of the works, the report states that no additions were made to the generating plant in the city. Two 2500-kilowatt motor converters were added to the Dickinson-street direct-current distributing station. A 33,000-

volt supply has been brought into that centre, and the first section of the new alternating-current distributing station completed. Additional office accommodation has also been provided. No additions were made to the generating plant at Stuart-street. At Barton the first two main turbo-generators and the first seven boilers were completed and in commission at March 31st, 1924. The third turbo-generator was in service early in the following April. Fair progress has been made with the erection of the eighth and ninth boilers. Efficiency trials have been made on one of the main boilers, showing that the plant is up to the specified performance. The result of similar trials on the turbine-room plant is not yet available. The best monthly overall thermal efficiency obtained up to date is 20 per cent., corresponding to a consumption of 16,506 B.Th.U. per kilowatt-hour generated, a figure so far unsurpassed by the published results of any steam station in this or other country.

Institution of Mechanical Engineers.

The afternoon spent by the members of the North-Western Section of the Institution of Mechanical Engineers in the works of David Brown and Sons, Limited, Huddersfield, on the 4th inst., was full of interest. There is probably no better equipped factory of the kind in the country than that of Messrs. Brown. During the last decade it has grown to vast dimensions. The works are devoted exclusively to the manufacture of toothed gearing of every conceivable variety, from the common spur to the quadruple helical. Most of the gears are cut on machinery of the firm's own design and construction. The visitors were conducted through all the departments, including the drawing-office, the foundries, pattern shops, smiths' shop, hardening and annealing departments, and machining sections, where they saw, amongst other things, the cutting of very heavy double helical steel gears 8in. pitch on the end mill principle, as well as the more common sizes of double helical gears on the generating principle. On the generating machines made by Messrs. Brown an arrangement of oblique reciprocating cutters is carried in a vertically moving slide and operates alternately from the edges of the rim to the centre line. These machines enable double helical teeth to be formed complete to the apex. Although the plant at Messrs. Brown's works is not at present employed to anything like its full capacity, the visitors were agreeably surprised to find several departments so busy.

BARROW-IN-FURNESS.

Hematites.

Whilst there is no marked improvement to report in the general condition of the hematite pig iron trade of this district, the position is a little better. The business being done is still on a small scale, and only immediate requirements are being covered at present, there being no inclination to order for future delivery. The total district output has been increased this week by the putting into blast at Barrow of the two furnaces which were closed down in March last owing to lack of orders. A good proportion of the make of these two furnaces will be absorbed by the local steel trade. There is no rush of orders, but it is hoped the activity at Barrow will be maintained, if not expanded, in the immediate future. Stores of iron have been depleted of late and the whole of the iron made is going into prompt use. Prices are steady. There is not much on offer in special iron; charcoal is in steady demand on a limited output. Manganese meets with only a fair business and little spiegel is being offered.

Iron Ore.

A somewhat fuller demand exists for hematite iron ore with the re-lighting of the two furnaces at Barrow. The total output of ore in North Lancashire, however, is small, most of the activity being at the Roanhead mines near Barrow. In West Cumberland there is a tendency to increased output. Spanish ores are particularly quiet and no cargoes have reached Barrow for some weeks now.

Steel.

The general demand for steel, particularly rails, is very quiet all round and orders are difficult to secure. At Workington the rail mills have been running for a few weeks, but there is again quietness. At Barrow some orders are held and the mills will be on together with the producing plant, &c., next week. The hoop and special section mills at Barrow are well employed.

Shipbuilding and Engineering.

In these trades only one day's holiday was observed this week. The shops and yard are getting busier, as recent orders booked are taking shape. The fitting out of the Orient liner Orama is proceeding.

Fuel.

For fuel there is a shade better demand, especially for East Coast coke.

SHEFFIELD.

(From our own Correspondent.)

Decline in Steel Production.

THE cheerless condition of things in the raw and semi-finished steel trades, which I have been reporting for several weeks, is accentuated this week. There is still an absolute dearth of substantial orders, and in many cases deliveries have been suspended. Figures with regard to the production of steel during April are now available, and, as was anticipated, they show a decline. The output in the Sheffield district was 35,600 tons of acid steel, 54,500 tons of basic, 3800 tons of Bessemer acid, and 5700 tons of other ingots and castings, the total being 99,600 tons, or 13,000 tons less than in March, and 9000 tons less than in April last year. Lincolnshire produced 41,000 tons of basic steel, no acid, and 200 tons of other steel, a drop of 12,000 tons on the March figures, and of 6000 tons as compared with April last year. It is expected that the figures for May, when published, will show a further reduction. So marked is the falling off in the basic open-hearth department that several more large furnaces in the district have been put out of action for want of orders for soft billets. There are still many orders for railway material on hand, and others continue to be received, but the work is not sufficient to keep the plants fully employed. The wagon builders are enjoying much activity, and have enough orders to keep them busy for a considerable time. The Whitsuntide holiday lasted in most cases three days, but at some works the resumption was more deferred.

Crucible Steel and Tools.

The crucible steel trade makes slow progress. From some of the leading makers come reports of slight but continuous increase in the demand, but the dealers in ferro-alloys have been doing badly for a long time, and their experience indicates that very little high-speed steel is being made. A good trade is being done in magnet steel. The demand for saws keeps up very well. The Sheffield article has now apparently recovered the ground which it lost to America some years ago, and has acquired an excellent reputation throughout the Colonies. The colonial markets are also taking good quantities of Sheffield tools of various kinds. Mr. A. K. Wilson, managing director of Spear and Jackson, Limited, who during the past eleven months has been touring Australia, New Zealand, Canada, and South Africa, reports that he found signs of good opportunities for enterprising firms, especially in the Antipodes, and that there is a great desire in the countries he visited for British manufacturers to go out and see the trading conditions for themselves.

Cutlery and Plate.

For the most part these trades are only moderately employed. There is a well-maintained demand for stainless table knives, but for high-class articles of cutlery and plate the demand shows little improvement. There is, however, a little expansion to report in the scissors and penknives branches. The amount of trade coming forward from the Colonies is scarcely up to the average of the early part of the year, but some ground has been gained in neutral markets. The demand for sports trophies is reported to be somewhat below the normal. A good many large special orders for cutlery and plate lines are being booked. The Admiralty is inviting tenders for 3000 pairs of carving knives and forks, as well as quantities of table knives, tailors' shears and other cutlery.

Low Temperature Carbonisation.

An important extension of the activities of Low Temperature Carbonisation, Limited, is about to be inaugurated near Nottingham. The company intends to erect plant at Gedling for the purpose of treating the small coal from the Digby Colliery. Some particulars of the scheme have been given by Sir H. Dennis Readett-Bayley, chairman of the Digby Colliery Company, Limited, who believes that low temperature carbonisation will make England independent of other countries for oil supplies. "Every thousand tons of coal of average quality raised, sold, and burned in its raw condition," he says, "is a loss of from 18,000 to 20,000 gallons of oil from which motor spirit, Diesel, lubricating and other oils can be distilled. At the Gedling plant small coal will be treated for the extraction of motor spirit fuel and lubricating oils, and the residue will be a perfectly smokeless fuel for domestic and industrial purposes. I hope to see Nottingham the first smokeless city in the country. A plant of a capacity of only 1000 tons a day will, as a beginning, give Nottingham something like 250,000 tons of smokeless fuel a year at a price not higher than the best domestic coal. This smokeless fuel can be used either for household or manufacturing purposes." Sir Dennis attaches great importance to the effect of low temperature carbonisation on the oil question. "Quite apart from the coming world shortage," he says, "it is absurd that Great Britain should have to buy £50,000,000 worth of oil every year when, to my thinking, science is able to turn our own coal mines into rich oil wells. A plant with a capacity of 1000 tons a day can yield over 7,000,000 gallons of crude oil and over 1,000,000 gallons of motor spirit a year. Nottingham and neighbourhood will have to hand also its own source of supply for Diesel and other lubricating oils." The plant will also produce 700,000,000 cubic feet of gas of fine quality annually, and there is a prospect of the Corporation of Nottingham entering into an agreement to take gas from the new enterprise. Sir Albert Ball, chairman of the Gas Committee, states that, if it would be a distinct advantage to the city to take from the company the supply of gas generated by it in the course of its process, it would be done. That would necessitate laying down a gas main some three miles in length.

Gas and Electricity.

An interesting development of the Sheffield Gas Company's undertaking is to be brought about by the company's purchase of two small local plants—that of the Dronfield Gas Company for £20,600, and that of the Handsworth Woodhouse Gas Company for £23,000. The scheme has been approved by the shareholders of all three companies, and it is not anticipated that there will be any objection from the Board of Trade. The district of the Handsworth Company is within the area originally allotted to the Sheffield Company, which, however, in years gone by did not wish to exercise its rights in that district. The Dronfield Company carries on its operations on the border of the Sheffield Company's area. Preparations are being made for the extension of the Sheffield Corporation's electricity supply to Greenhill, Norton, Coal Aston, Dronfield Woodhouse, and Dronfield, all places within a few miles of the city on the Derbyshire side. The Town Clerk of Sheffield recently wrote to the Dronfield Urban District Council, pointing out that the Corporation's proposal in respect of the other places named was being held up because Dronfield had not yet made its application and would not sign the agreement with Sheffield. It was decided to communicate with the Electricity Commissioners to the effect that the Dronfield Council would be glad to hear that the application of the Sheffield Corporation had been granted, providing an undertaking was given that Sheffield would bring a cable through to the Dronfield boundary within a reasonable time.

An £80,000 Sewerage Scheme.

An important sewage scheme is projected by the Chesterfield Corporation, which has decided to abandon its existing works, four in number, and to build a new and up-to-date one at Whittington. The effluent from the present works has from time to time been the subject of adverse comment from the County Medical Officer. The total cost of the new works, including additional sewers, will be £82,673. An interesting point is that it has been decided to adopt the system of bio-aeration or activated sludge devised by Mr. J. Haworth, the general manager and chemist at the Sheffield Corporation sewage works, and carried out at the extensions of those works, at Rotherham, and other places. Mr. Haworth is advising Chesterfield in connection with the new scheme. The proposed works will deal with a dry-weather flow of two and a-quarter million gallons per day.

A Sheffield Pullman.

The comforts of travel between Sheffield and London have been increased by the inauguration of a Pullman service on the London and North-Eastern Railway. The train, which makes the journey once each way daily, stopping only at Nottingham, consists of one first-class and four third-class coaches and provides seating accommodation for 22 first-class passengers and 130 third-class. The first-class car, Geraldine, is built to standard Pullman dimensions, being 63ft. 10in. over vestibules. It has steel underframes, and all-steel bogies of the four-wheel pattern, with long wheel base. The speed of the train averages 52.5 miles per hour, excluding stops, and in places reaches as high as 67 miles per hour.

Vickers' New Tank.

Dragon, one of the new tanks made by Vickers Limited, of Sheffield, took part in a mimic battle at Chobham Ridges on Saturday, in the presence of the King and Queen, and created a striking impression. A report of the operations states that the vehicle, which is "half tank and half armoured car, carries a crew of four and a number of small guns, is armour protected, and can travel on its caterpillar tracks at a rate of 25 miles an hour. No obstacle seems too great for it to surmount. With a series of snake-like movements it ploughed easily through entangling grass, sank into troughs of mud, but immediately extricated itself, forged its way through pools of water, and then traversed the level ground like a motor car at about 20 miles an hour."

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THE feeling in commercial circles is more pessimistic than it has been for a long time past, and certainly it is difficult to discover ground for hope of early recovery in trade. Inactivity is not unusual at this season of the year, but at present the quietness of the position is more pronounced than is generally experienced. In the iron and steel trades new business is very difficult to secure. Scarcely anyone is prepared to buy forward either raw materials or finished products. Gradually order books are being thinned down without anything like an equal booking of business. The outlook is, indeed, very discouraging.

Cleveland Iron Trade.

The position of the Cleveland pig iron trade is far from satisfactory. The amount of new business moving is of very small proportions, and there is a marked uncertainty all round. Production of iron at present is more than ample to meet the whole of the needs of users, and at some of the works stocks are reported to be accumulating. Cleveland producers have once more lost their overseas markets. The slump in the franc and the consequent lower cost of production in France and Belgium has enabled the continental producers to cut them out, and even the home market is now threatened with their attacks. Without foreign trade Cleveland cannot find full employment for its plant, and unless there is an early change in the situation production may have to be curtailed. As yet there is no suggestion of stopping blast-furnaces, but that is a contingency that may speedily arise unless something occurs to give a stimulus to trade. The efforts of some makers to maintain the price of No. 3 G.M.B. Cleveland pig iron at 91s. per ton seem to have been abandoned, and 90s. is now the general market quotation—the lowest figure recorded this year. No. 1 foundry iron is 95s., No. 4 foundry 89s., and No. 4 forge 88s. per ton.

Hematite Pig Iron.

Conditions in the East Coast hematite pig iron trade show no material change. The output considerably exceeds the demand, and stocks at makers' yards continue to increase. Prices are weakening. For mixed numbers 98s. per ton is now a full figure, and there has been business at 97s. 6d., with No. 1 at a premium of 6d. per ton.

Ironmaking Materials.

Consumers of foreign ore still have very large stocks, and sales are hardly heard of. In the continued absence of transactions quotations are nominal. Recognised market rates remain on the basis of 23s. 6d. per ton c.i.f. Tees. Good Durham furnace coke is selling at anything from 27s. to 28s. per ton delivered at the works.

Manufactured Iron and Steel.

Very unsatisfactory and discouraging accounts are given of most departments of the manufactured iron and steel trade, the exception being the sheet producing branch, which is reported to be busy. Not only has there been a marked revival in the demand for sheets, but values have taken an upward turn, and galvanised corrugated sheets are now quoted at £18 per ton for 24in. gauge. A few specifications continue to come forward for shipbuilding material, but other sections of the trade are exceptionally quiet. Quotations are unchanged.

The Coal Trade.

There is no change in the general situation throughout the coal trade, and business is almost idle. The shorter output this week will tend to allow some accumulation of tonnage, but in any case the supply is ample to meet all requirements, and what is solely needed is increased business. Operators show no signs of interest in the trend of the market, either for prompt or forward, and supplies continue to be abundantly offered, without finding any competition. Second-hand sellers are not pressing on the market, as the coals held by them are at prices much above the current value, and consequently their movements are handicapped. The fitters, while entertaining any odd bit of business offered, are not forcing the market, preferring to leave it to the contractor to secure whatever business is available. There is no life in the inquiry from the Continent, and, with work at the German mines again in full swing, no special inquiry is expected, and the prospects for the whole month are both dull and disappointing.

Floating Dock for Lagos.

The floating dock, which Swan, Hunter, and Wigham Richardson, Limited, have built at their Wallsend Shipyard, was successfully launched on Friday last. The dock, which is 270ft. long over the pontoons, with two end platforms each 20ft. long, making up a total length of 310ft., is of the double-sided, self-docking type, and consists of a lifting portion formed of five similar pontoons attached to two parallel side walls which are continuous over the whole length. The machinery will consist of two installations, each drawing from a common main drain, and will be capable, when working together, of lifting a vessel of 3000 tons in about two and a-half hours. The dock will be towed direct to Lagos in the course of a week or two.

SCOTLAND.

(From our own Correspondent.)

Depressing Conditions.

THE position in the steel, iron and allied industries continues unfavourable and the outlook leaves much to be desired. Nothing was made public during the past week calculated in any way to brighten the prevailing dullness in the various markets. Business on all hands has been slow and almost devoid of interest. It seems at present to be almost impossible to lessen the high costs of production which constitute the barrier to an increased turnover. In spite of this lack of fresh orders prices of most products remain on the same level as for weeks or months past, while buyers continue to reiterate the impossibility of paying such charges and making a profit. Producers likewise maintain the impossibility of reducing their prices. The position seems, therefore, somewhat in the nature of a deadlock. Some, if not many, concerns are taking orders which merely pay expenses, and some even at a slight loss, in order to keep the machinery moving. Such a state of affairs cannot continue indefinitely, and rumours of closing down are becoming more numerous. Continental offerings have been more numerous of late, but reports indicate that small success attends such offerings. The hope is still entertained that much brighter conditions will be established after the holiday season is over, but it is difficult to discern at present from what direction the improvement is to emanate.

Pig Iron.

The market for pig iron shows little movement. Home orders are few and far between, and the export turnover leaves a great deal to be desired. Hematite and foundry qualities are, nevertheless, firm at £5 2s. 6d. per ton for hematite, £5 5s. No. 1 foundry, and £5 per ton No. 3 foundry, all for Glasgow delivery.

Finished Steel and Iron.

Steel makers are considerably disappointed with the business, or perhaps it would be more correct to say the lack of business, filtering through from the shipyards. A goodly number of shipbuilding contracts have been placed in recent months, but specifications in connection with them have been exceedingly slow to materialise. Specifications for plates and sections, especially the former, are very difficult to obtain, and the mills are poorly engaged. Steel sheets have fairly steady employment, but the work in hand is not now so large as was the case a month or two ago. Home demands for sheets are far below expectations, and any improvement is in export directions. Heavy gauges are poorly bought. The bar iron trade continues to move slowly, and competition is keen. Re-rolled steel has slackened somewhat, and easier prices are quoted round about £9 15s. per ton home or export. Scrap material is not finding a ready sale, but as in the case with other materials, the prices are firmly maintained.

Easier Tendency in Coal.

The position of the coal trade became even less satisfactory during the past week. The export branch of the trade was relieved from a modified form of stagnation by the announcement that, included in the Swedish State Railways contract over June, July and August, were 74,000 tons of Cowdenbeath-Lochgelly coal. General export business was slack, and the shipments dropped 40,000 tons on the week. The total clearances for the week amounted to 260,179 tons, against 300,713 tons in the preceding week and 295,121 tons in the same week last year. Prompt business for abroad is not very favourable, while forward negotiations are almost out of the question at present. Some cheap prices have been offered in order to effect a clearance at the pitheads, but the collieries are not getting rid of their stocks, and there has been some talk of closing down temporarily. The home market likewise has been dull throughout. Consumers will not commit themselves to fresh contracts, and only minimum immediate requirements are negotiated. Practically all classes of coal show further price reductions.

Shipbuilding Contracts.

Norwegian owners have ordered two twin-screw motor propelled oil-tank vessels from the Blythswood Shipbuilding Company, Scotstoun. The vessels will be of 13,000 tons deadweight capacity. The machinery in both vessels will be of the Burmeister and Wain-Harland and Wolff type. Barclay, Curle and Co., Limited, Whiteinch, are to build for Messrs. Harris and Dixon, London, a sister ship to the Swanley, launched in March last by the same builders. The vessel is of 5000 tons gross, and the machinery will be the new double-acting Diesel engine designed and manufactured by the North British Diesel Engine Works, Limited, Whiteinch.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THERE was not much activity in coal market conditions immediately before the holidays, as exporters were concentrating their attention upon getting away the tonnage which they had loading in view of the fact that it was impossible to say what might be the labour position this week arising from the railway shopmen's strike. This week, of course, has been dull from the point of view of business owing to the holidays, and it is practically certain that nothing much will be done before next week. Most exporters have made their arrangements for the loading of steamers which were due to arrive during the holidays, and although the stoppage in the coalfield covered the first three days of the week, there is no doubt that the standing coals will be quite sufficient to meet immediate demands, as the coal trimmers and tippers were idle during the first two days of the week and loading operations were not therefore resumed until Wednesday. New business which has come along of late has been very meagre, and the majority of firms with low-priced coal contracts have experienced great difficulty in finding an outlet for their supplies without incurring a loss, to say nothing of making a profit. The only order which has come to this district of late that is of any appreciable size is that for the supply between now and the end of October of 24,000 tons of large steam coals for delivery at Haiffa for the Palestine Railways. This business, from all accounts, has been secured by Watts, Watts and Co. The general demand from continental quarters continues to be extremely small and competition is keen to a degree. The summer months as a rule provide a quiet time, and it looks very much as if the next two or three months will accord with precedent, as there are no extraneous factors that can be seen at the moment which are likely to place a different complexion upon the outlook.

Sectional Railway Strike.

The position regarding the railway shopmen's strike on the Great Western Railway so far as this district is concerned continues to be anything but clear. Claims are made by the unofficial leaders of the movement that the strike is spreading and hints are made of developments this week, while, on the other hand, rebutting statements are issued from official quarters which give ground for optimism that the strike need cause no alarm. In any event the outstanding fact emerges that so far nothing has occurred to interfere with the shipment of coals from South Wales. The strikers have been doing their utmost to get the power-house men to throw in their lot with the movement, but the number of men who have done so is negligible, and though meetings of the power-house men have been held the only decision of a definite character that has been come to is that a ballot shall be taken on the question of supporting the strikers or otherwise. This step has been adopted by the Cardiff men. The Newport Railway shopmen have decided to remain loyal to their union and not to strike. The unofficial leaders have declared that there are 4000 shopmen at Cardiff and in the Valleys who are on strike, while branch meetings of railwaymen at Cardiff and Port Talbot have passed resolutions calling upon the Executive Council of the National Union of Railwaymen to recognise the strike. The Cardiff No. 1 branch of railwaymen has decided in the event of the position not being cleared up to hold a mass meeting of all grades on Sunday next to decide what action may be necessary to assist the shopmen to obtain their demands. According to an official statement issued at the end of last week, hydraulic men, greasers and repairers at Cardiff, Penarth, Barry and Port Talbot are on strike, and the working of the appliances may be affected later when attention by them is required. Cranes at Barry are not working, so that discharging operations on steamers is at a standstill.

LATER.

ON Wednesday there was a further development in the railway shopmen's strike. The strikers' committee issued a circular alleging that railway officials and clerks at the docks during the holidays carried out work ordinarily done by men out on strike, such as oiling capstans, travelling engines, cranes, tips, &c., and appealed to the tippers to take action. The Cardiff tippers have therefore called a meeting to consider the position, while at Port Talbot the traffic men have been requested not to put any coal on the sidings of the appliances which had been oiled by "blackleg" labour. It was further unanimously decided that traffic men would cease work on Sunday night next if no settlement is meantime reached or the strike made an official one by the National Union of Railwaymen.

Larger Coal Wagons.

The movement started by the Great Western Railway Company for the construction and use of 20-ton wagons is reported to be going ahead, and in addition to the 1000 wagons already ordered, the delivery of which is expected to commence in a month or two, it is stated that wagon builders and hirers are receiving numerous inquiries. At South Wales good progress is being made in the reconstruction of coal shipping appliances in order to accommodate the larger wagons. Already there are eighteen appliances available for the 20-ton wagons, and eleven more are under reconstruction, while thirteen new tips are on order.

Third Shift Movement.

A further effort is being made to secure the working of a third shift by the coal trimmers and tippers at South Wales. Arrangements have been made for a conference of officials of the Great Western Railway Company and the N.U.R. representatives of the tippers, to take place in London shortly for the purpose of framing a financial arrangement which will meet with the acceptance of the workmen. In the event of this conference terminating satisfactorily the shipowners will then approach the coal trimmers in order to secure agreement concerning a night-working arrangement.

Current Business.

The tone of the steam coal market has been quiet, doubtlessly by reason of the holidays as well as of the paucity of the foreign demand. The fact that at least half a week's output has been lost should have a steadying effect upon the market, as this reduction will enable coal-owners to dispose of a great part of their standing stocks. Nominally there has been no change in prices, and it will be fully next week before the conditions settle and business is resumed. Anthracite coals rule steady, except possibly duff coals, which have been easy. Patent fuel has displayed no feature, but pitwood has been weak, supplies having arrived pretty freely.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that the board of directors of the Scottish Tube Company, Limited, at a meeting held in Glasgow on Friday, May 30th, unanimously appointed Mr. Andrew Eadie, chairman of the company as successor to the late Sir Thomas Mason.

ALLEN-LIVERSIDGE, Limited, inform us that they have moved from 106, Victoria-street, Westminster, S.W. 1, into larger offices at Victoria Station House, Westminster, S.W. 1. The lighting, heating and power installation department remains as before at 123, Victoria-street, Westminster, S.W. 1, where the company's showrooms will also be situated.

MR. WILLIAM CORIN, M. Inst. C.E., M.I.E.E., M.I.E. (Aust.), late Chief Electrical Engineer in the N.S.W. Department of Public Works, and now in practice as consulting engineer, asks us to state that he has moved his office from temporary premises at 8, Spring-street, Sydney, to the South British Building, 28, O'Connell-street, Sydney. Telephones, B2612 (temporarily B4047), Wahroonga 556.

CONTRACTS.

THE VICKERS AND INTERNATIONAL COMBUSTION ENGINEERING, Limited, of Africa House, Kingsway, London, W.C. 2, has received an important order from the City of Birmingham electricity department for a complete pulverised fuel installation for the Nechells power station, to consist of the following:—Six Vickers-Spearing boilers, each having 5400 square feet of heating surface, to give superheated steam at 325 lb. per square inch, and each boiler having a Lopulco type combustion chamber; four steel plate bunkers; four gravity type dryers; four Raymond roller pulverisers; two compressors and apparatus to convey the fuel from the pulverisers to bunkers above the boilers; six groups of Lopulco feeders operated by variable speed electric motors; and twenty-four Lopulco burners. This contract has been accepted by Vickers and International Combustion Engineering, Limited, on strict efficiency guarantees, and for the use of fuel of low calorific value.

WORLD POWER CONFERENCE.—The opening reception of the World Power Conference will be held on Monday, June 30th, at the Conference Halls, British Empire Exhibition. H.R.H. the Prince of Wales has graciously consented to be present, and to welcome delegates from the thirty-five participating countries. This function will take place in Hall 1 at 3 p.m., and it is hoped that, in addition to the official delegates, there will be a large attendance of enrolled members of the Conference. The official banquet will take place in the evening of Monday, June 30th, at the Queen's Hall, Langham-place, W. 1, at 7 for 7.30 p.m. The President, the Right Hon. the Earl of Derby, K.G., will preside.

DIESEL ENGINE TESTS AT WALLSEND.—Some time ago it was announced that the Wallsend Slipway and Engineering Company, Limited, of Wallsend-on-Tyne, had decided to manufacture under licence the Sulzer type of marine oil engine. We now learn that the first Wallsend-Sulzer engine has recently completed its shop trials. It is a four-cylinder unit, intended for a single-screw ship, and designed to develop 1800 brake horse-power at 90 revolutions per minute, or 2000 horse-power at 100 revolutions per minute. In accordance with usual practice the engine drives the air compressor and the lubricating pumps, only two further auxiliary cooling water pumps and a scavenge air blower being required when the engine is running. During a sixty-hour non-stop trial the engine developed 1800 brake horse-power, running at 90 revolutions per minute and a consumption of 0.378 lb. of fuel oil per brake horse-power was obtained, while during a six-hour trial at 2000 horse-power the consumption of fuel was 0.36 lb. per brake horse-power-hour. Further tests included manœuvring and slow-running trials, which were successfully carried out.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	23/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 2 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 17 6	4 17 6
No. 1	4 18 6	4 18 6
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 9 0	4 9 0
No. 4 Forge	4 8 0	4 8 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 7 6 to 4 10 0	
" " Foundry	4 15 0	—
(3) Northampton—		
Foundry No. 3	4 11 0	—
" Forge	4 5 0	—
(3) Derbyshire—		
No. 3 Foundry	4 14 0	—
Forge	4 7 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 14 6	—
No. 4 Forge	4 13 0	—
Basic	4 11 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 12 6 (a) / 5 17 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best "	—	—
N.E. COAST—		
Common Bars	12 10 0	—
LANCS.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best "	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	13 0 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	12 0 0	
Gas Tube Strip	13 5 0 to 13 7 6	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 10 0	—
Ship Plates, ¾in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 5/16in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light "	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
MANCHESTER—		
Bars (Round)	10 5 0 to 10 15 0	
" (others)	10 0 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
" (Soft Steel)	13 15 0	13 10 0
Plates	10 0 0 to 10 5 0	—
" (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 0 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	10 0 0 to 10 10 0	
Billets and Sheet-bars	7 15 0 to 8 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 15 0	
Angles	9 17 6 to 10 0 0	
Joists	9 17 6 to 10 0 0	
Tees	10 17 6 to 11 0 0	
Bridge and Tank Plates	10 10 0	—
Boiler Plates	14 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	22/7½ to 22/10½
Block Tin (cash)	209 12 6
" (three months)	208 17 6
Copper (cash)	61 15 0
" (three months)	62 15 0
Spanish Lead (cash)	30 15 0
" (three months)	28 12 0
Spelter (cash)	31 0 0
" (three months)	31 2 6
MANCHESTER—	
Copper, Best Selected Ingots	67 10 0
" Electrolytic	68 5 0
" Strong Sheets	94 0 0
" Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
" Condenser	0 1 2½
Lead, English	34 0 0
" Foreign	33 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	10/6
" 6 p.c. to 8 p.c. "	£23 10 0	8/-
" 8 p.c. to 10 p.c. "	£23 0 0	8/-
" Specially Refined		
" Max. 2 p.c. carbon	£42 10 0	16/-
" " 1 p.c. "	£31 0 0	17/6
" " 0.75 p.c. carbon	£68 0 0	20/-
" carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
" Silicon, 45 p.c. to 50 p.c.	£12 0 0	scale 5/- per unit
" " 75 p.c.	£18 10 0	scale 6/- per unit
" Vanadium	19/3 per lb.	
" Molybdenum	8/3 per lb.	
" Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£135	
Cobalt	10/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	17/6
" " Ell	19/-
" " Splint	20/- to 22/-
" " Trebles	20/6
" " Doubles	20/-
" " Singles	17/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	17/6
" " Splint	20/-
" " Trebles	20/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	19/- to 21/-
Screened Navigation	26/6
Trebles	21/-
Doubles	20/6
Singles	18/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	18/3
Secondary Steam	17/6
Trebles	21/-
Doubles	21/-
Singles	18/-

ENGLAND.

(3) N.W. COAST—	
Steams	32/-
Household	49/- to 59/-
Coke	35/-
NORTHUMBERLAND—	
Best Steams	21/6 to 22/-
Second Steams	20/- to 21/-
Steam Smalls	13/6 to 14/-
Unscreened	18/- to 20/-
Household	27/-
DURHAM—	
Best Gas	23/- to 23/6
Second	20/6
Household	27/-
Foundry Coke	26/- to 28/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	34/- to 35/- —
Barnsley Best Silkstone	28/- to 29/- —
Derbyshire Best Brights	28/- to 30/- —
" " House	25/- to 27/- —
" " Large Nuts	24/- to 26/- —
" " Small "	18/6 to 20/6 —
Yorkshire Hards	23/- to 24/- —
Derbyshire "	21/6 to 23/6 —
Rough Slacks	12/6 to 15/6 —
Nutty "	12/- to 14/- —
Smalls	8/- to 10/- —
Blast-furnace Coke (Inland) *	
" " (Export)	f.o.b. 27/- to 28/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	27/9 to 28/3
Second " "	26/6 to 27/6
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	25/- to 26/-
Best Black Vein Large	26/6 to 27/-
Western Valley "	26/- to 26/6
Best Eastern Valley Large	25/- to 26/-
Ordinary " "	24/- to 25/-
Best Steam Smalls	18/- to 18/6
Ordinary "	16/6 to 18/-
Washed Nuts	25/- to 27/-
No. 3 Rhondda Large	28/- to 29/-
" " Smalls	24/- to 25/-
No. 2 " Large	24/6 to 25/6
" " Through	21/- to 23/-
" " Smalls	16/- to 17/-
Coke (export)	50/- to 55/-
Patent Fuel	28/- to 30/-
Pitwood (ex ship)	26/6 to 27/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	47/6 to 52/6
Seconds	42/6 to 45/-
Red Vein	30/- to 32/6
Machine-made Cobbles	57/6 to 62/6
Nuts	52/6 to 62/6
Beans	42/6 to 45/-
Peas	27/- to 28/-
Breaker Duff	9/3 to 9/6
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large	24/- to 26/-
Seconds	22/- to 24/-
Smalls	15/- to 19/-
Cargo Through	18/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

*Blast-furnace Coke (Inland): Special Price for Ironworks 23/-, open market 27/- (at ovens). † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Situation.

THE feeling of uncertainty that has pervaded the iron, steel and engineering trades has become so far accentuated that it is quite impossible for manufacturers to make any provision for the future. The uncertainty applies more particularly to the absence of any indication as to the attitude of the new Government, when it is formed, towards the Ruhr occupation and the question of reparations generally. Manufacturers as a body approved of the Ruhr occupation because they believed that it was the only means of compelling Germany to supply the coke necessary for the iron-making industry, and because it also provided the economic pressure necessary to force that country into fulfilling its Treaty obligations. Now that there is a question of modifying this policy, the whole industrial community is waiting to see what is likely to be done, and until the outlook becomes clearer no one is disposed to make any commitment, with the result that the situation generally has become stagnant. There is no stability in prices and no possibility of giving quotations, except on short option, and, as quotations are rarely asked for, the fluctuations in prices have really little importance. It must be admitted that the situation would be less satisfactory than it is if it were not for the material being supplied to foreign countries, such as tanks, aeroplanes, aviation engines and the like. The requirements in connection with public works, railways and Government Departments are being withheld, and private buying is very limited in view of the uncertain outlook, while the factor which is most strongly influencing the situation is the monetary stringency, which is due partly to the heavy fluctuations in the exchange rate. There appear to be very few orders of any importance, but it is interesting to learn that the State Railways are continuing the tests of automatic couplings, for which purpose an order has been placed for a thousand Henricot apparatus for the equipment of 500 vehicles.

Paris Extensions.

The Paris Municipal Council and the Department of the Seine had prepared an extensive programme of improvements comprising the laying out of the fortifications for building pleasure grounds, the solving of the housing problem by creating garden cities in the suburbs, and the extension of the Port of Paris, at an estimated cost of 300 million francs. The Senate has reduced this sum to 180 million francs, including 74 million francs for the port. The reduction was made on the ground that it was desirable to limit expenditure to what was strictly necessary in pursuance of the policy adopted by the Government to authorise no further expenditure for which there was not a corresponding revenue. The Municipal Council, however, which has always objected to State interference in municipal affairs, considers that there is no valid reason for this cutting down of the programme, and it is suggested that it would be prudent to hold the scheme up altogether rather than to risk partial failure by half measures. While it was hoped that the housing problem would have been solved by the carrying out of the project, it is found necessary to provide for the growing pressure upon the public transport service. In addition to the extensions being made to the Metropolitan Railway, it is now proposed to incorporate into the system the Paris-Auteuil electrified line owned by the State Railways and at present running at a serious loss on account of the Metropolitan competition, and also the inner Ceinture Railway and the Bastille-Vincennes and Luxemburg-Sceaux-Palaiseaux lines. If this were done it would mean an extension of the Metropolitan Railway to the suburbs, which has been under consideration for years past.

Liquid Fuel.

The efforts of the Government to encourage the use of a motor fuel in which alcohol and other home and colonial ingredients would be employed, have not met with the success anticipated on account mainly of the cost. It will be remembered that an attempt was made to render compulsory a mixture of petrol with 10 per cent. alcohol, and the loss upon the alcohol was partly made up for by an additional tax on petrol. The difficulty, however, became almost insurmountable when it was found that a mixture in that proportion could only be effected with absolute alcohol, whereby the cost was still further increased. The Government nevertheless has not lost hope of achieving satisfactory results, for the Comité Central de Culture Mécanique, which is a department of the Ministry of Agriculture, has invited chemists to communicate an account of their researches into the production of motor spirit and engine fuels from vegetable and mineral oils, and the necessary funds will be provided, as far as possible, to carry out the research and experimental work. At the same time the Comité Central de Culture Mécanique has decided to organise this year another exhibition of agricultural tractors and army lorries running on suction gas and vegetable oils. There will also be a congress dealing with all matters appertaining to the production of a national motor fuel from vegetable and mineral oils.

Concrete Roads.

In view of the exceptional opening that would be offered to concrete firms if only the advantages of concrete for road construction could be demonstrated sufficiently to insure the general adoption of this material, they have formed a company to carry out exhaustive tests with the aid of concrete-laying machines imported from the United States. The company has taken possession of nearly a mile of road, at Bry-sur-Marne, which has been divided into sections and laid with different kinds of concrete, with and without joints. Each section has been laid by a different firm. While the initial cost is high it is claimed that experience in the United States proves that the concrete roads are more economical on account of their much greater durability, and a further advantage is that only native material would be employed.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C. at 1s. each.

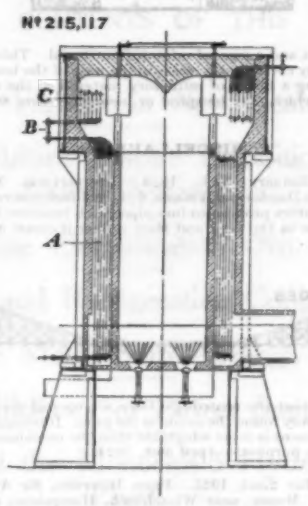
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

215,117. February 7th, 1923.—HIGH-PRESSURE BOILERS, A. G. Bugden, 54, Eswyn-road, Tooting, London, S.W. 17, and R. P. Wallis, Point Pleasant Hall, Point Pleasant, Wallsend-on-Tyne.

In this boiler steam is generated at the critical pressure and temperature of 3200 lb. per square inch and 374 deg. Cent. in

Nº 215,117



the coils A. It is then passed through the reducing valve B and the expansion has the effect of converting it into perfectly dry vapour. The vapour is then superheated to any desired degree in the coils C. The specification includes a number of drawings and gives details of the construction of the boiler.—*May 7th*, 1924.

CONDENSERS AND FEED-WATER HEATERS.

215,171. April 11th, 1923.—FEED-WATER HEATING SYSTEMS FOR STEAM TURBINES, K. Baumann, Northwood House, Barnfield, Urmston, Lancs., and the Metropolitan-Vickers Electrical Company, Limited, 4, Central Buildings, Westminster.

This system of heating feed and make-up water is said to obviate priming from the make-up evaporator. The drawing shows a steam turbine, condenser, extraction pump A, feed-water heaters B and C, and evaporator D. On their water sides the heaters are connected in parallel between the extraction pump and the boiler feed pump (not shown), and on their steam sides they are connected with an operative stage of the turbine and the water space of the evaporator D. The steam space of the evaporator is connected with a higher pressure operative stage of the turbine by a pipe controlled by a valve E, and drains F and G, the latter controlled by a valve H, connect the steam

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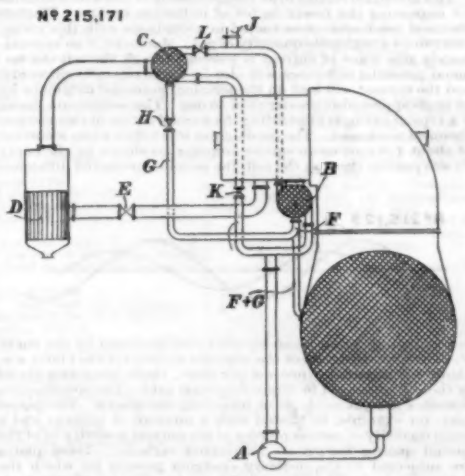


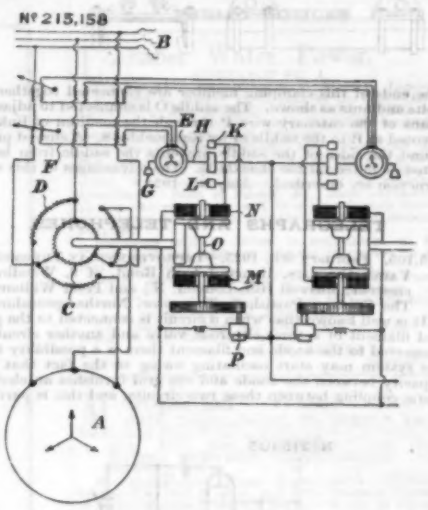
spaces of the feed-water heaters and the condenser. In operation make-up water is admitted to the plant by way of the evaporator D. Condensate from the extraction pump flows in parallel through the heaters B and C, where it is heated by steam tapped from a stage of the turbine and generated in the water space of the evaporator D respectively, and from thence to the feed pump by way of pipe J. This arrangement requires only one large air-tight valve E and prevents access to the turbine of any water which may pass over from the evaporator through priming. It also readily permits of the complete isolation of the evaporator D and the feed heater C, which can be effected by simply closing the valves K, L, E and H. When the evaporator and feed-water heater C are isolated from the plant the whole of the feed water will flow through the heater B, the heat transference in which will automatically increase in proportion to the quantity of water flowing therethrough.—*May 8th*, 1924.

DYNAMOS AND MOTORS.

215,158. March 20th, 1923.—IMPROVEMENTS RELATING TO INDUCTION MOTORS, *The British Thomson-Houston Company, Limited, Crown House, Aldwych, W.C. 2.*

This invention relates to auxiliary means for temporarily increasing the voltage applied to induction motors during peak loads. In the diagram A represents a three-phase induction motor connected to mains B and provided with a regulator comprising a rotor winding C and a stator winding D. A load relay E is connected in series with the motor either directly or through a transformer F and may be formed of a hollow cylinder of very thin aluminium capable of movement in the field of the three-phase winding. The low intertia of the cylinder enables the displacement to be almost instantaneous. The torque of relay E is balanced by means of a counterweight G. An arm H on the relay E carries a contact, which is adapted to close one of two

Nº 215,158



contacts K L when the load on the motor exceeds a predetermined limit. The closing of one of the contacts K L energises one of the electro-magnets M N, which attracts a plate on a clutch mechanism O. This engagement allows a continuously running direct-current servo-motor P to drive the shaft of the rotor winding C of the regulator in such a direction as to increase the voltage on the motor A. Resistances may be provided in series with the electro-magnets M N in order to diminish the time constant. If the variations of load are very rapid, a device may be provided for shunting the relay E and causing the servo-motor P to be clutched on the regulator so as to increase the voltage to a maximum. When the peak loads have been passed the apparatus becomes automatic again. This arrangement is of special use during the rapid initial passings of the blooms in rolling mills.—*May 8th*, 1924.

TRAMWAYS AND RAILWAYS.

198,997. April 13th, 1923.—IMPROVEMENTS IN APPARATUS FOR CONTROLLING VEHICLES DRIVEN BY DIRECT-CURRENT SERIES-WOUND ELECTRIC MOTORS, Brown, Boveri and Cie., of Baden, Switzerland.

The control system described in this specification will readily be understood from the accompanying diagram. According to the invention the weakening of the field of traction motors is accompanied by a weakening of the field of the locking

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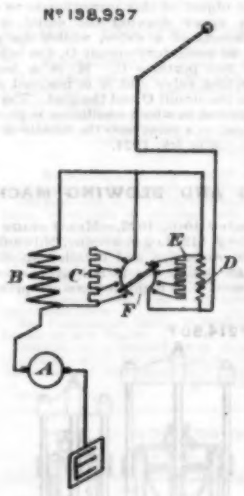
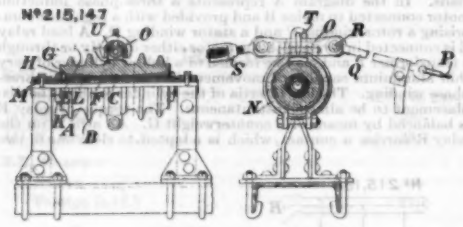


magnets, limit current relays, &c., so that these devices are caused to act by a higher total current. In the accompanying diagrammatic drawing A represents a motor armature, B its series field, and C a regulable shunt for reducing the strength of the field B. The controlling arm F is double-ended and controls the shunt C of the field B and a shunt E which reacts upon a relay magnet coil D and weakens the effect of this coil according to the weakening of the main field B.—*May 1st*, 1924.

215,147. March 9th, 1923.—IMPROVEMENTS IN AND RELATING TO INSULATORS FOR USE ON ELECTRIC RAILWAYS AND THE LIKE HAVING OVERHEAD CONDUCTOR WIRES, Sir Philip Dawson, of St. Stephen's House, Victoria Embankment, Westminster, and Frederick William Fawdry, of 36, Emperor's Gate, South Kensington, S.W. 7.

The object of this invention is to provide improvements in contact line insulators and their connections to catenary wires for the purpose of avoiding fracture due to any part of the insulator being placed under tension. The insulator has a ridge A with inclined sides and two or more circumferential flanges B. The ends of the passage C are coned outwards as shown. The relative dimensions of the sleeve and the tube E are such that waterproof, textile or resilient packing material F may be interposed between these two members, the ends of the packing space being closed by washers G and H composed of leather and

steel respectively. The nuts K prevent moisture entering. A secondary insulator may be provided by placing an insulating tube L of fibre between the insulating-material and the metallic tube E and the porcelain insulator. The steel tube E is mounted upon a spindle M, the ends of which being supported in standards. A two-part clamp N surrounds the central ridge on the insulator.

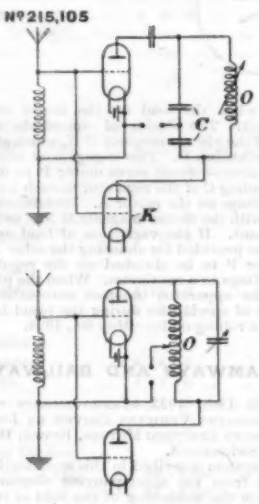


The ends of this clamping member are connected together by bolts and nuts as shown. The saddle O is connected to adjacent spans of the catenary wire P through the medium of links Q pivoted at R to the saddle or by turnbuckles S. A curved pin T round the sides of the saddle prevents the saddle from being ifted or jolted off the shackle U. The advantages of this construction are described.—*May 8th*, 1924.

TELEGRAPHS AND TELEPHONES.

215,105. February 5th, 1923.—IMPROVEMENTS IN THERMIONIC VALVE CIRCUITS, Henry Joseph Road, of 9, Woodbury-crescent, Muswell Hill, London, N., and Peter William, of The Cottage, Pattishall, Towcester, Northamptonshire.

It is well known that when a circuit is connected to the grid and filament of a three-electrode valve and another circuit is connected to the anode and filament there is a possibility that the system may start oscillating owing to the fact that the capacity between the anode and the grid furnishes an electrostatic coupling between these two circuits, and this is particu-

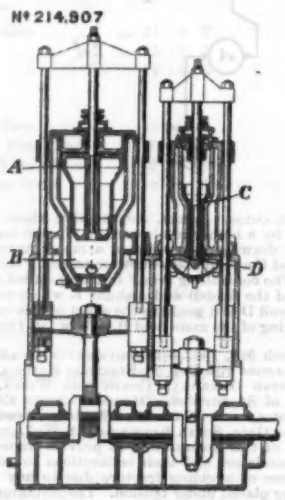


larly true if instead of a single valve several valves are arranged in cascade. The object of this invention is to overcome this trouble. In the upper drawing the aerial is connected to the grid and filament of a valve, whilst the plate or anode is connected to an oscillatory circuit O, the capacity of which is divided into two portions C. K is a burnt-out valve similar to the acting valve and it is inserted as a balancing capacity between the circuit O and the grid. The lower diagram shows an arrangement in which oscillation is prevented by connecting the filament to a point near the middle of the inductance of the circuit O.—*May 5th*, 1924.

PUMPING AND BLOWING MACHINERY.

214,907. September 10th, 1923.—MULTI-STAGE COMPRESSORS, B. V. Nordberg, 512, Logan-avenue, Milwaukee, Wisconsin.

This is a most extensive and detailed specification, which suggests that the design illustrated overcomes most of the troubles experienced with high-pressure compressors. The first

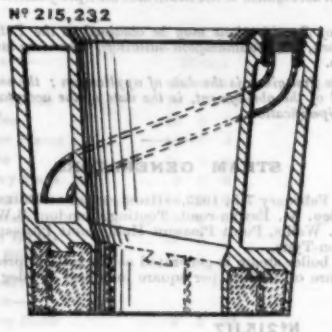


stage of compression is effected by the double-acting piston A, while the remaining three stages are single-acting and are effected at B, C, and D. Intercoolers are provided between the several stages, and return connecting-rods are employed to improve accessibility.—*May 1st*, 1924.

FURNACES.

218,232. August 2nd, 1923.—BLAST-FURNACE TUYERES, G. Beaton, 212, Whitney-avenue, Sydney, Nova Scotia.

This invention essentially consists in forming a blast-furnace tuyere with a cylindrical body portion having an annular



water jacket and a nose of refractory material. This nose may be formed by coring out a recess in the nose of the body portion and inserting a filling of refractory material in the recess, the bottom of which may be spiral or inclined.—*May 8th*, 1924.

MISCELLANEOUS.

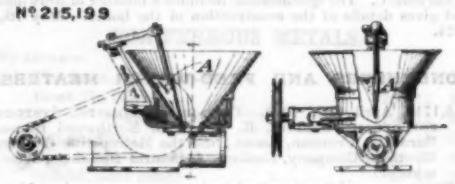
215,068. January 30th, 1923.—CENTRIFUGAL MOULDING, *Melville Dundas and Whitson*, 224, *St. Vincent-street, Glasgow*.

The inventors propose to line pipes with concrete by putting the concrete in the pipe and then rolling it down an inclined

runway, so that the centrifugal force set up will distribute the concrete evenly round the inside of the pipe. It is suggested that the arrangement is more adaptable than the machines generally used for the purpose.—*April 30th*, 1924.

215,199. May 22nd, 1923.—FEED HOPPERS, Sir A. Herbert, Dunley Manor, near Whitchurch, Hampshire, and P. V. Vernon, Keresley Manor, Keresley, near Coventry.

This invention is concerned with hoppers for feeding such materials as moist slack coal, which are liable to cling to the sides



of the hopper. The inventors thus arrange a plough-shaped scraper A in the hopper and rotate either the hopper or the plough, whichever may be the more convenient. The illustration shows a rotating hopper driven by worm gearing and a link belt.—*May 8th*, 1924.

215,129. February 16th, 1923.—MEANS FOR INTRODUCING CAPACITY EFFECTS IN ALTERNATING ELECTRIC CURRENT SYSTEMS AND APPARATUS, Thomas Frederick Wall, of Carr Bank House, Fulwood, Sheffield.

This invention relates to an electro-chemical condenser suitable for improving the power factor of induction motors. Electro-chemical condensers constructed in accordance with this invention evolve a negligible quantity of gas. Moreover, if an approximately sine wave of current is passed through the cell the terminal potential difference will also be approximately sinusoidal and the current will lead on the terminal potential difference by an angle appreciably greater than 45 deg. The oscillogram shown is a typical example illustrating the normal action of this electro-chemical condenser. The oscillogram was taken when a current of about 1.6 root mean square ampères (as shown by the curve C) was passing through the cell, the terminal potential difference

being about 2.3 root mean square volts, as shown by the curve V. The immersed area of the opposite surfaces of the plates was about 100 square centimetres per plate, there being two plates in the cell immersed in dilute sulphuric acid. The specification describes several methods of preparing the plates. The plates may, for example, be pasted with a mixture of litharge and a small quantity of carbon powder of the normal quantity or of the special quality known as "activated carbon." These plates are subjected to the ordinary charging process by which the litharge is reduced either wholly or in part to spongy lead. They are then washed and dried by heating at a temperature of, say, 270 deg. to 300 deg. Cent. in a normal atmosphere or in a suitably restricted atmosphere. The use of activated carbon facilitates the oxide formation during drying and may also help during the process of reduction to spongy lead. Other methods of making the plates are also described.—*May 8th*, 1924.

THE award of Mr. Justice Wylie as to the claim of the Irish railways' clerical staff has just been given. It is wholly in favour of the staff except those in the higher grades. Of the male clerical staff 60 per cent. benefit, 95 per cent. of the women clerks, and 55 per cent. of the station masters and supervisors.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science South Kensington, S.W. 7. Ordinary meeting. 5 p.m.

TO-DAY AND SATURDAY, JUNE 14TH.

ASSOCIATION OF MINING AND ELECTRICAL ENGINEERS.—Annual meeting in London. Headquarters, Midland Grand Hotel, St. Pancras, N.

WEDNESDAY TO FRIDAY, JUNE 11TH TO 13TH.

INSTITUTION OF WATER ENGINEERS.—Summer meeting at Coatbridge and Glasgow. For programme see page 598.

MONDAY, JUNE 16TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Dominions and Colonies Section meeting. "The Mineral Wealth of the Pre-Cambrian in Canada," by Dr. C. V. Corless. 4.30 p.m.

WEDNESDAY AND THURSDAY, JUNE 18TH AND 19TH.

NEWCOMEN SOCIETY.—Summer meeting at Shrewsbury. For programme, see page 654.

FRIDAY, JUNE 20TH.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting of the Transmitter and Relay Section. Discussion on "Tuning Coils," will be opened by Mr. A. J. Cooper. 6.30 p.m.

TUESDAY, JUNE 24TH.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Langham Hotel, Regent-street, London, W. 1. Summer meeting. 9.30 a.m.

WEDNESDAY, JUNE 25TH.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Lecture, "A *Résumé* of Modern Methods for the Measurement of Radio Signal Strength," by Mr. J. Hollingworth. 6 p.m.

TUESDAY TO SATURDAY, JUNE 24TH TO 28TH.

INSTITUTION OF NAVAL ARCHITECTS.—Summer meeting in London. For programme see page 628.

WEDNESDAY TO SATURDAY, JUNE 25TH TO 28TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Annual general meeting in London. For programme see page 551.

THURSDAY, JUNE 26TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Natural History Museum, South Kensington, London, S.W. 7. Annual conversazione. 8.30 p.m.

SATURDAY, JUNE 28TH.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Excursion to Castleton, Derbyshire, under the leadership of Professor Owen T. Jones.

MONDAY TO SATURDAY, JUNE 30TH TO JULY 12TH.

WORLD POWER CONFERENCE.—At the British Empire Exhibition, Wembley. For programme see page 126.

TUESDAY TO SATURDAY, JULY 1ST TO 5TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Eighty-third Annual Show at Leicester.

WEDNESDAY AND THURSDAY, JULY 2ND AND 3RD.

BRITISH WATERWORKS ASSOCIATION.—Annual general meeting at Sheffield. For programme see page 580.

MONDAY TO WEDNESDAY, JULY 7TH TO 9TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Summer meeting in London. For programme see page 369.

STANDARD RAILWAY RAILS.—The British Engineering Standards Association has recently revised the British standard sections of flat-bottom railway rails from 25 lb. to 100 lb. per yard. The revision involves some alterations in the British standard specification, a revised edition of which is in course of preparation; it will include four additional sections of 105 lb., 110 lb., 115 lb., and 120 lb. per yard. The primary object of the revision of the sections was to dispense with the double angle in the flange, which had been the cause of considerable trouble and expense in manufacture owing to the necessity for the constant re-dressing of the rolls; but many other alterations have been made in the new designs which, it is considered, should result in the sections being used on many railways which have not hitherto adopted the British standards. It has been found impracticable so to design the sections as to allow the existing standard fish-plates to be used, and a revised edition of Report No. 47–1919, British Standard Specification for Fish-plates for Railway Rails, covering new standard fish-plates for use with the modified rails, will shortly be issued. It will, however, be possible to employ many of the existing types of bearing plates and metal sleepers. Copies of these publications may be obtained from the B.E.S.A. Publication Department, 28, Victoria-street, Westminster, S.W. 1; or from Messrs. Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4, price 1s. 2d. post free.